Adding Years to your Life

Henry Smith William[illegible] L.L.D.

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[illegible] of simple but highly effective gymnastics aimed at [illegible] development of the abdominal muscles

Adding Years To Your Life

By

Henry Smith Williams, M.D., LL.D.

Author of "A History of Science," "The Science of Happiness," "The Effect of Alcohol," etc.

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ADDING YEARS TO YOUR LIFE

I

The Duel with Old Age

GROWING old and dying seem futile performances, when you stop to think of the matter.

Just why a man who has lived in unvarying health and strength for, say, thirty years should not continue to do so for three hundred or three thousand years is not intrinsically obvious. Certain enthusiasts have all along contended that he could do so if only he could find out just how the trick was to be accomplished.

In the Middle Ages, this idea seemed so self-evident that no one thought of doubting it. So hosts of men of talent gave their lives to the quest of the philosopher's stone.

Then there were men of another cast of mind who believed that the special elixir of life must be a product of nature herself rather than of the laboratory, and who sought the beneficent fountain of eternal youth in far-off regions of the world. Foremost among these adventurers, as every schoolboy will recall, was Ponce de Leon, who sought—but failed to find—the beneficent spring in Florida.

In our day the problem has been attacked from many angles. There are no unexplored lands to search out, and at last we are forced to believe

that nature has nowhere supplied a spring of eternal youth. But there are still workers in the laboratory who believe that the dream of the alchemists was not a hopeless one, and who are attempting to apply the new knowledge of modern science to the old familiar quest.

Metchnikoff, Seeker After Eternal Youth

The Ponce de Leon of our day is Professor Elie Metchnikoff, of the Pasteur Institute in Paris. Professor Metchnikoff gained world-wide fame some twenty-five years ago through his researches on the white blood-corpuscles. He proved that these little organisms in the blood have the function of destroying bacteria and thus of helping man to preserve his health. This demonstration prepared the way for much of the later progress of preventive medicine. It also suggested to Professor Metchnikoff himself problems having to do with the life and death of human tissues that have been the stimulus for all his more recent work. Latterly this work has focused specifically on one subject, the conquest of old age. The savant himself believes that he has at last partially solved the problem.

A beginning in this direction was made by Professor Metchnikoff some years ago when he observed that the peasants of Bulgaria appeared to be a very long-lived race. Metchnikoff noted that the peasants in question lived largely on a diet of sour milk. He associated this custom with

the observed longevity and sought for the connection. Milk sours because of the presence of certain microbes called lactic-acid bacilli. Hence sour milk contains a large quantity of these minute organisms. Tracing the history of these bacilli when taken into the stomach, Metchnikoff found that they live and proliferate in the intestinal canal, and there tend to neutralize certain poisons that are deleterious to the human system if absorbed.

Acting on these observations, Metchnikoff introduced a sour-milk treatment which has been extensively employed by physicians all over the world. It must be admitted, however, that the results of this treatment have not been convincing to the mass of the profession.

Glycobacterium—Bacillus of Long Life

Metchnikoff himself has felt that the lactic-acid bacillus was hampered in its beneficial activities by the lack of food suited to its needs to be found normally in the intestinal tract. So he sought a means of remedying this difficulty. Very recently a clue was given by the discovery, made by M. Woolman, a fellow-worker at the Pasteur Institute, of a bacillus which can generate sugar, and which has been given the name "glycobacterium."

This newly discovered organism was found in the intestinal tract of the dog, but it may be cultivated in the laboratory and made to colonize in the human system.

The advantage of such colonization is, according to Professor Metchnikoff, that by supplying food for the lactic-acid bacilli, the glycobacteria will be instrumental in enabling those organisms to carry out their useful functions of neutralizing the so-called indols and phenols, the presence of which in the intestinal tract is believed to be so deleterious to the organism.

It will be obvious that the real utility of the glycobacteria in performing this highly desirable function can be determined experimentally only after many years of trial. But, on the other hand, it cannot be supposed that a scientist of Professor Metchnikoff's reputation makes any conclusions without a good many facts or valid theories to give them support. Let us inquire, then, very briefly, as to the grounds on which Professor Metchnikoff's belief that he is on the track of the philosopher's stone is based.

Professor Metchnikoff's chief efforts, as we have seen, are aimed against certain poisons that are generated in the intestinal tract.

There is no question that these poisons are actually generated there, and that they are capable of absorption into the system and of producing deleterious effects. In a crude general way this has been familiar knowledge of medical men from the earliest times; though it remained for the physiological chemist of our time to test and classify and name the poisons.

It is recorded that the medieval alchemist-physician, Paracelsus, believed that all foods con-

tain elements of poison, and that it is the function of the gastric juice to act as an alchemist, transforming the poisons into wholesome products. With a little latitude of interpretation, the idea is not far wrong. All foods do contain elements that, if not properly compounded, would be poisonous to the system. The chief universal elements that enter into foodstuffs are carbon, hydrogen, oxygen, and nitrogen.

Properly compounded, these are not only wholesome, they are absolutely indispensable; but if you break up the molecules of, let us say, meat or bread into their elements, you may have a variety of poisons.

Thus carbon unites with oxygen to form the poisonous carbonic acid gas, which if not immediately thrown off by the lungs, suffocates or asphyxiates the cells in general and causes death. Similarly oxidized, the nitrogen and carbon and hydrogen elements of the food-molecule may form, and constantly do form, in the system urea and uric-acid compounds that, if not immediately eliminated by way of the kidneys, produce stupor and death with equal certainty. These are familiar facts of elementary physiology.

But does it not seem probable that elimination of these poisons is sometimes only partially performed? Every physician knows that such is the case. A whole coterie of diseases are of such recognized origin.

May it not be true, then, that a slow poisoning occasioned by partially retained organic com-

pounds is the cause of that gradual decay which leads to senility and death?

To this question Metchnikoff answers unequivocally, Yes. He believes that auto-intoxication, through the acumulation in the system of waste products, is very largely responsible for the fact that tissues in the body gradually lose their power of normal reproduction and ultimately functionate so feebly as to cause the individual to become senile and to die.

Single-celled Organisms Never Die

The original conception that probably put Professor Metchnikoff on the track of this idea was the theory of Professor Weismann, according to which single-celled organisms (so-called infusorians or protozoans) never die a normal death. The idea is startling, but simple enough when we consider the conditions. If you observe a protozoan under the microscope you will see a translucent particle of protoplasm which moves about, seemingly responds to stimuli (as from coming in contact with other objects), absorbs certain particles by way of food, and excretes such portions of the food as are not to its liking.

The bit of protoplasm will be observed to grow until it attains a fairly definite maximum size.

Then it will become constricted at the middle, presently dividing into two bits of protoplasm each of which is precisely like the original in quality and activities, but of half size.

Each of the new protozoa will re-enact the life of the parent of whose divided body they are composed. Each will feed and grow and presently divide to constitute two offspring. As the process of growth and so-called reproducton by fission requires only a few hours, there will be successively two, four, eight, sixteen, thirty-two, sixty-four protozoa where at first there was only one. And this process continuing, it is obvious that the progeny of the original protozoan increase in geometrical ratio, until in the course of a few weeks they will number—as anyone who chooses to make the successive multiplications can prove—thousands, millions, billions, of individuals.

If nothing interfered with their growth, there might be tons of them in a few weeks.

Meantime what has become of the original protozoan? It is rather curious to reflect on the successive divisions of the fleck of matter that composed it. The entire body of the protozoan, it will be recalled, divided to produce two protozoa. These offspring, then, are not merely children of the original protozoan; they together constitute the total bulk and personality of the original organism.

And so with each successive generation. The parent organism is larger but no older than its two offspring; and, extending the idea all along the line, it would seem that, of the myriads of protozoans, those of the last generation represent merely the divided personality of the first protozoan, and are as old as their original ancestor.

The thing sounds paradoxical when phrased in just that way, yet it seems to express the fact.

Stated otherwise, it appears that the protozoan never dies, but, barring accidents, is perpetuated throughout the ages in an unending series of descendants that represent not offspring so much as a continuity of its own person.

This idea of the "potential immortality" of the single-celled organism, as Weismann phrased it, took instant possession of the biological world, and led to renewed questioning as to why the cells should lose this capacity for immortality when they chanced to be built together into the organism of a higher animal.

The matter seemed so important, that it was presently put to tests, to establish whether the protozoan really is immortal as Weismann thought. Some of these experiments were disconcerting. Professor Maupas studied a particular type of protozoan, carefully isolating one individual out of each successive generation, and he found that a time came, after two or three hundred generations, when the individual protozoa seemed to deteriorate in size, to lose their power of reproduction, and to die.

This seemed to suggest that mortality is really inherent in the cell, and that old age and death are inevitable for single-celled and many-celled animals alike.

But many biologists refused to consider these experiments as demonstrative. There were some who believed that the decadence of Professor

Maupas' protozoans was due to the development of unfavorable conditions in the course of the experiment. Further observations proved that this was correct. Renewed experiments, in particular those of Enriquez, Woodruff, and Professor H. S. Jennings, of Johns Hopkins, demonstrated that if the food supply is properly adjusted and the waste products are properly removed from the medium in which the protozoan lives, a strain of protozoa may be kept in perfect health, without showing the slightest tendency to degenerate, for thousands of generations, and presumably for an indefinite period.

So the idea that the normal single-celled organism is potentially immortal, and never comes to its end except through violence, or what may be termed disease, seemed experimentally established. And the fact that protozoans under unfavorable conditions develop disease and die seemed to give renewed color to the idea that the many-celled animals, including man, owe their mortality to the development of unfavorable conditions, rather than to any innate propensity to die.

The Application to Man

Clearly to understand the logic of this attempted applicaton of the life history of the protozoan to the human organism, we must bear in mind that every animal body, including that of man, is built up exclusively of cells that by

themselves are not very different from the bit of protoplasm that constitutes the body of the protozoan.

It is an old axiom of physiology that all life comes from an egg. The original egg from which a human body develops is a miscroscopic bit of protoplasm which the casual observer would not very sharply distinguish from a protozoan. Like the protozoan, this divides presently into two cells, and then in succession into four, eight, sixteen, and so on indefinitely.

But, unlike the offspring of the protozoan, the new cells of the successive divisons of the human embryo do not scatter in all directions and take up individual existences. They remain clinging together and form a larger and larger cluster. Presently some of them assume different shapes from others, though all sprang from the same parent. In time some of their descendants are grouped into clusters that we call muscles; others into structures we call bones, and the like.

All these structures, it must be recalled, are direct descendants of the original egg-cell, and in the main they retain the primitive function of taking in nourishment, growing, and excreting waste products.

But inasmuch as the various groups of cells thus piled together to form organs are necessarily shut off from direct contact with the medium from which they absorb foodstuffs, it has become necessary to build up, with the aid of other cells, channels of communication through which the

foodstuffs may be distributed. Thus the tubular structures known as the intestinal tract, the blood-vessels, lacteals, and lymphatics, bronchial tubes, and glands, and kidneys and perspiratory apparatus, have been developed.

All these are merely accessory mechanisms to enable the remote cells of the body to gain a food supply and to rid themselves of waste products.

The human body, then, may be closely likened, in comparison with the protozoans, with the human population of a city as contrasted with a lone hermit in the country. The lone hermit, like the protozoan, lives in direct contact with the medium from which his foodstuffs are obtained. He personally performs all the labor necessary to his own maintenance.

But the city dweller, like the gregarious cell of the developed body, is a specialist, performing one or another type of labor and depending on other specialists for the performance of other necessary types. Some are day laborers, comparable to muscle cells; some are professional workers, comparable to brain cells; some are engaged in bringing in food products; others in the removal of waste products.

Similarly the houses are of necessity constructed with streets between them to serve as channels through which the food products may be brought in and the waste products removed.

A city without these channels of communication would be as hopeless a proposition as a human body without mouth or lungs.

Is Mortality the Price of Differentiation?

Let us bear this comparison between the human body and the city population in mind and extend a little further our reasoning from the life history of the protozoans.

Many of the most thoughtful of biologists who have noted the potential immortality of the protozoan—and the number includes Professor Jennings, whose experiments were just referred to—are clearly of opinion that when the cells aggregate together to form a single body, instead of scattering individually, as do the successive generations of protozoa, they create artificial conditions that make indefinite existence impossible.

Just as Professor Maupas' protozoa presently degenerated and died because the experimenter had failed to maintain ideal conditions of food supply and of the removal of waste products, so, according to these opinions, it is intrinsically impossible in such a vast colony of cells as that making up the human body, to maintain the ideal conditions of food-supply and waste-removal that are essential to maintenance of perpetual health of the individual cells, and hence to perennial youth and immortal life for the individual organism.

These objectors argue that there can be no great gain without some attendant loss. The clustering of cells together to form a differentiated body makes possible all the gains that lie

between the life of a protozoan and the life of a man. The loss involved is that of the primal capacity of the protoplasmic cell to live indefinitely.

"The higher diversified life is purchased at the price of ultimate death."

According to this view, which is put forward prominently by Professor Sedgwick Minot, of Harvard, it is intrinsically impossible that such a vast colony of cells as that making up the human body should maintain the ideal conditions of food-supply and waste-removal that are essential to the maintenance of the perpetual health of the individual cells, and hence to perennial youth and immortal life for the aggregate body of cells called a human being.

Thus, says Professor H. S. Jennings, in interpreting the theory, "Age and death, though not inherent in life itself, are inherent in the differentiation that makes life worth living."

Now it is obvious that if this view of the matter is correct, the modern scientific quest of the philosopher's stone is as chimerical an undertaking as the voyaging of a Ponce de Leon.

But is this assumption necessarily valid? Is it not a little like saying that the necessary penalty of combining human habitations into cities is the defective feeding of the population, defective sanitation, and the attendant prevalence of disease and early average mortality?

Such were indeed the penalties of city life throughout the Middle Ages and until compara-

tively recent times. The water supply of most cities was defective and contaminated; the methods of bringing food were crude and subject to interruption; garbage and refuse were habitually thrown into the streets to become a source of contamination of the air and the breeding of pestilence. Infant mortality was appalling; plagues and epidemics were of perpetual recurrence; and it, was necessary constantly to replenish the city population from the country, or the race of city dwellers would have died out altogether.

But all this has been changed in our day.

Now, as everybody knows, life is nowhere more healthful than in our large cities. Nowhere else is the water supply in general purer; nowhere else does one find better food supplied in more abundant quantity; nowhere else are the sanitary conditions so good, and the systems of removing waste products so hygienic and so effective. As a consequence, nowhere else is the general health better or the mortality rate lower than in our well-managed cities. The death rate in New York City is lower than in New York State outside the city.

And all this has been brought about in defiance of what seemed to our forefathers necessary conditions deleterious to health and longevity incident to the very nature of city life.

And so the question naturally arises, may not biologists of to-day be similarly in error when they declare it impossible that the conditions of

life for the cells of the human body should be made so healthful as to give the cells a chance for indefinite longevity?

Growing Tissues Outside the Body

Only the experiments of the future can determine the matter. But it seems to lie within the possibilities, in view of the biological facts just quoted, that the thing might ultimately be accomplished. In other words, it seems a justifiable conclusion from the observed facts, that there is no necessary limit to the activities of the aggregation of matter that we call protoplasm.

It seems a fair inference that if we could make the conditions in a human body so ideal that every cell to the remotest tissue should be bathed in a medium of blood and lymph containing just the right proportions of food in just the needed quantity, and supplying also ideal conditions for the removal of waste products, we should have an organism that would live on indefinitely.

That this inference is obviously in accord with the traditions of the alchemist is of no particular significance one way or the other. That it gives support to the hopes and dreams of such investigators as Professor Metchnikoff, is a matter of greater moment.

A review of the conditions as thus presented, however, will make it clear, I think, to any thoughtful reader that there is no probability whatever that any single discovery, such as Pro-

fessor Metchnikoff's discovery of the function of the glycobacterium, can by itself result in accomplishing the feat of giving the body eternal youth. Whatever the importance of the waste products in the intestinal tract, which the glycobacterium is expected to neutralize, it would be absurd to suppose that they are all-important.

There are questions of food supply, and of elimination of waste products through other channels, that must obviously have consideration.

Until these are solved, we shall have taken only the first step in the direction of maintenance of perennial youth.

Fortunately we may record that just at the moment there are new possibilities opening up to the scientific investigator in this field, that are of quite a different order from any hitherto available. This grows out of the extraordinary experiments in the cultivation of living tissues outside the body that have been carried out in recent months by Drs. Carrel and Burrows, at the Rockefeller Institute in New York.

These experimenters cut fragments of tissue from the dead body of a chicken, or dog, or other animal, and by supplying these tissues with a proper medium, cause them to live and grow in glass receptacles, keeping up cell-growth and cell-division as if they were still a part of the original parent organism.

In order to keep the tissues alive for long periods, however, it is necessary, as might be expected, not only to supply a medium having

proper food qualities, but also to change this medium from time to time, in order that the waste products may be removed. In other words, the conditions for these fragments of tissue outside the body are precisely those that obtain in the cultivation of the protozoans. The same essential elements of pure food and complete elimination of waste products must be fulfilled in order to maintain the life and health of the cell. Thus it is demonstrated that the individual tissues of the body do not necessarily die when the animal ceases to breathe.

So far as can be judged, the tissues under glass in Dr. Carrel's experiments would live indefinitely. He even keeps bits of a heart beating in his glass receptacles for months after the creature from which the fragment was taken died and was buried.

This clearly shows that it was not inability of the heart-muscles to functionate that caused the animal's heart to cease to beat.

The same thing is shown in another way by the experiments of Dr. Meltzer, also of the Rockefeller Institute. He kills dogs and other animals, and then restores them to life by artificial respiration. His method has been applied to human beings who had been suffocated in mines, and to those who had been killed by an electric current.

All this new knowledge, then, seems to make it clear that the death of any given individual by no means necessarily implies that his tissues have lost their inherent vitality. In the view of the

followers of Metchnikoff, it suggests that if just the right conditions could be found, man need not die except by accident—including in the category of accidents the attacks of specific diseases.

Putting the matter in its baldest form, the question may be said to be reopened as to whether the familiar phrase, "natural death," is not a misnomer.

But is not the question answered, you say, in the observed fact that all higher animals are mortal? Not necessarily, replies the follower of Metchnikoff; because it is by no means certain that man or any higher animal ever does die a strictly natural death.

That is surely a startling assertion, yet it will bear close examination. The most casual inspection of mortality tables will show that the vast majority of deaths are due to a small coterie of allied diseases that have this essential common factor: they are all caused by microbes which invade the body and overwhelm the normal tissues.

Guests that Shorten Our Lives

Even under conditions of what is termed perfect health, the body is still the seat of myriads of bacteria of many species, which grow and thrive by untold billions on all the mucous surfaces of the mouth and digestive and respiratory tracts.

These bacteria have such powers of reproduction that, if conditions were favorable, the

progeny of a single one would increase in a few weeks to such dimensions as to outbulk the entire body of their host. They are kept from this disastrous development only by the constant efforts of the cells of the body in which they lodge.

Now these bacteria are protoplasmic cells that feed on the same essential substances that nourish the cells of the human body; and in so far as they thrive in the body they make the conditions of life difficult for their host.

They not only absorb to their own use nutriment needed by the body-cells, but they secrete waste products that are deleterious in greater or less measure to the human organism.

It is these poisons alone, in the view of Metchnikoff, that cause the decay and ultimate death of the human tissues. But for the presence of bacteria, in this view, the cells of the human body would continue their functioning—granted a proper supply of food and normal conditions of excretion—indefinitely, just as do the isolated cells of the protozoa in a sterile and properly renovated culture medium.

But unfortunately the bacteria cannot be excluded. There is not a human being or a higher animal of any kind that does not harbor in its digestive tract a population of bacteria outnumbering the aggregate human population of the globe since the race was developed. The laboratory worker is able to prove that protozoa are immortal, because he is able to provide a medium from which bacteria are excluded. But the ex-

periment cannot be duplicated with any higher animal, because there is no conceivable way of providing the body-cells with a sterile medium.

No way conceivable just at present, that is to say. But may not the way be found? Is it not possible that man may ultimately exterminate at least such of the hosts of bacteria as live only in his body?

It seems an almost hopeless task; yet it is true that even now the more noxious microbes are being subordinated. In any contest it is much to know just who are your real opponents. To-day man knows, for the first time, who are the real enemies of his prolonged existence.

Knowing our enemy, we are learning to fight him. His deadliest cohorts represent a few chief tribes, the members of which flourish exclusively or mainly in the human body, producing there adverse conditions that we personify and name as if they were tangible personalities—smallpox, plague, tuberculosis, pneumonia, diphtheria, cholera, typhoid fever, and the rest.

To-day preventive medicine is grappling with these hosts, and seems in a fair way to banish most of them.

A century ago smallpox claimed by death about one-tenth of the entire population. To-day smallpox has been virtually banished.

Twenty years ago diphtheria was the scourge of childhood; to-day it is held securely in check by the antitoxin of Behring.

Ten years ago typhoid fever was a menace that

threatened everyone; to-day the vaccine of Wright offers immunity to whoever cares to use it.

Four years ago syphilis seemed an unconquerable pest; to-day the "salvarsan" of Ehrlich offers a specific that cures in a single dose.

A year ago cancer was the despair of the physician; to-day there is at least the hope that a remedy is being perfected in the hands of Von Wassermann and Ehrlich.

Meantime such workers as Metchnikoff are turning attention to microbes of that less virulent type that have learned to flourish in the body of their host without causing his early demise. Metchnikoff's newest experiment, as we have seen, is to fight fire with fire, as it were, by introducing into the intestinal tract bacteria of a new tribe to antagonize the poison-generating tribes that are already quartered there. Even if he succeeds, his results must be less spectacular than the efforts directed against the quick-acting disease-germs; yet the ultimate results may be no less important as they have to do with the definite prolongation of life.

Thus the men of science are closing in day by day on the ranks of the noxious microbes. The results are tangibly shown in the decrease of infant mortality, the banishment of epidemics, the lowered death-rate in cities, the making salubrious of the Panama Canal region, the extraordinary lengthening of the average period of life. Of the individuals born in our generation, a higher percentage will reach patriarchal years than lived

through childhood in the days of our grandparents.

All this may not presage the actual banishment of death, but it surely suggests that the scientific search for the fountain of eternal youth has proved a less futile and visionary quest than it once seemed.

Learning the Needs of the Cells

If our enemy, the microbe, should finally be held in check, it would remain to provide ideal conditions of nourishment and elimination for the cells of the body. And Dr. Carrel's new method of cultivating tissues outside the body offers hitherto unexampled opportunities for learning the needs of the cells.

It will be obvious that when fragments of tissue are thus cultivated, it becomes possible to test the effect of different foodstuffs upon the growth and health of the tissues in a way that was never possible while the tissue was part of a complex body. When time has been given for elaborate sets of such tests, we shall know, as no one has hitherto known, just what modifications of foodstuffs are beneficial to different kinds of tissues. We shall ultimately learn what quantities of food supplies are required, and just what are the absolutely normal conditions of the elimination of waste products.

We shall then know, for example, whether a meat diet or a vegetable diet is best for the human

organism, or whether a mixed diet is better than either. We shall know precisely what is the ultimate effect on each kind of tissue of such auxiliary foodstuffs and nerve stimulants as alcohol, tobacco, tea, coffee, and various condiments. In a word, we shall have a really comprehensive and scientific knowledge of the conditions of sanitation and hygiene, so to speak, for the individual cells of the human tissues.

Then it will be possible to put forward rules of diet and exercise, and, on occasion of medication, that will establish approximately ideal conditions for the organism as a whole.

It does not necessarily follow that we shall be able to make these conditions so ideal as to give the organism indefinite life.

It may be discovered, for example, that, in the differentiated body politic of the human organism, conditions that are ideal for one set of tissues may not be ideal for another. Indeed, there is a suggestion of this in the well-known fact that the muscular system of the average man tends to become old and decadent long before his brain begins to decrease in power.

So it may happen that we can never make the conditions just right for one set of cells without making them wrong for another; in which case we cannot hope to give the body immortal life.

But whether or not there should prove to be this limitation to the possible fulfillment of the hopes of the modern alchemist, there can be no question that it lies within the possibilities of

physiology and hygiene, even to-day, to improve the conditions under which the average man exists, so that life of the average individual may be very greatly prolonged, and the resilient conditions of youth maintained far into the period that we now term old age.

What May Be Done To-day?

Whatever else the new studies teach us, they show that all the tissues of the body should be given opportunity for healthful functioning, and all the channels of elimination kept freely in operation.

Professor Metchnikoff himself believes that there is little need of the services of his glycobacterium for persons whose diet is always what it should be. I would add, provided the person exercises to a reasonable degree. Without such exercise, I believe, it is impossible to keep up a proper blood supply to all tissues, and to insure a healthful degree of elimination.

Even with the best regimen and hygiene, and ideal habits of exercise and rest, we cannot of course hope that in our generation at any rate, we shall be able to produce even approximately ideal conditions in the bodily mechanism. No sane person, therefore, supposes that Professor Metchnikoff's discovery, or any other that our generation is likely to see, will solve the problem of perennial youth, let alone that of perennial life.

But, on the other hand, no well-informed physiologist doubts that the average man may even now, by the application of knowledge clearly in hand, ward off for a time the onset of old age, and prolong the term of his years. A large coterie of famous men of all ages—from Sophocles, Æschylus, and Euripides in antiquity, to Humboldt, Gladstone, Bismarck, and many others in modern times—have demonstrated that by right living it may be possible, without resort to lactic bacilli or glycobacteria, to carry the strength, vitality, intellectual acumen, and spirit of youth into the seventh, eighth, and ninth decades.

Now that preventive medicine is banishing the germs of contagious diseases that have been man's chief enemies in the past, the number of men and women who duplicate this record should increase by leaps and bounds.

Perennial life would be perhaps a doubtful blessing. But to remain young in spirit throughout our mortal span—never really to grow old—is a consummation devoutly to be wished for each and every one of us. And this possibility, I confidently believe, lies even now within the grasp of every average individual.

To suggest practical means to effect this end, for you and for your children, is the purpose of the ensuing pages, which deal with different aspects of the problem of attaining health, happiness, and long life through attention to personal hygiene.

II

The Battle of the Microbes

FEW, if any, of us escape the occasional inhalation or inhibition of the germs of tuberculosis.

If you have two children, there is more than an even chance that at least one of them is infected with these germs at the present moment, though the germs give no evidence of their presence. If your entire family comprises five individuals, the chances are one to two that at least one member will ultimately die of consumption—since that disease is credited with ten per cent of all deaths.

It numbers more than three thousand victims each week in the United States alone.

Nearly everyone has heard that smallpox formerly killed one-tenth of the population, as tuberculosis does now; and that it pitted the faces of a large proportion of the race, somewhat as tuberculosis pits the lungs of the great majority to-day. But after the celebrated Dr. Edward Jenner discovered the efficiency of vaccination, smallpox was soon under control. The disease was estimated to have killed fifty million people in Europe in the eighteenth century,—just about ten times the total population of the United States at the close of that century. But since

Jennerian vaccination was introduced, smallpox has been practically abolished except among uncivilized peoples and the very ignorant classes. It was so terrible a scourge that its name still excites popular apprehension; but the disease itself has no terror for anyone who chooses to avoid it.

Unfortunately there are enough ignorant and bigoted and careless people in the world to keep smallpox in existence; but the frightful epidemics that killed half the population of entire regions can by no possibility recur among any people intelligent enough to avail themselves of the beneficent privilege of vaccination.

In the same way tuberculosis, the great scourge of our time, will some day cease to claim its ten per cent of our race, for an immunizing virus is certain to be discovered. Even if the vaccines that are now being tested should prove disappointing, there can be little doubt that someone among the many investigators who are working on the problem will finally attain success. But at best a long time must elapse before the remedy can be universally applied; and one dare not predict the complete extirpation of this or any other germ disease until people in general are much more intelligently alive to their own interests than they are at present.

Popular Apathy

The curious and discouraging fact is that most people are strangely oblivious to the remediable

dangers that lie all about them, while they manifest keen interest in spectacular calamities that are far less momentous.

Thus everyone read with horror a few months ago that ten thousand Turks were reported to have fallen in a single battle with the Bulgarians; the newspapers scare-headed the accounts from ocean to ocean. But no newspaper thought to mention that many times ten thousand victims had fallen on the same day before microbic foes that are far more relentless than Turk or Bulgar. The toll of infant lives alone amounts to about forty thousand daily—one at every other tick of the clock, as a speaker at the recent International Congress of Hygiene computed.

For the most part these infants are slaughtered, in the sense that they fall victims to preventable diseases.

But the thing is too familiar to excite interest. It is hard to make a news item out of something that occurs every day.

Doubtless the chief cause of public apathy as to the slaughter of the innocents, however, results from lack of general understanding of the conditions of the one-sided combat in which the infants are vanquished. The mother who sends her infant to its grave does not do so wilfully; she acts only through ignorance. And the general public, which reads with complacency Professor Irving Fisher's estimate that six hundred and thirty thousand preventable deaths occur in this country each year, is complacent simply because of its

ignorance. It does not clearly apprehend what is meant here by the word "preventable." The old idea about the "visitation of Providence" still gives consolation to thousands of mothers who have really administered the death-potion to their infants with their own hands.

Knowledge as to the true and tangible cause of death is so new that physicians are only beginning to grasp it, and the general public cannot be supposed to have gained more than a vague inkling of it.

Legions of Enemies

It is perhaps not superfluous, then, to remind the reader that the vast majority of all deaths are due to the invasion of the human body by definite and tangible foes, which are no less real because they are of microscopic dimensions. The chief aim of medical science in our day is to combat these microbes, either by preventing their access to the body, or by making the body proof against them if they do find entrance.

Thus when we say that a person has consumption we mean that a microbe of a definite species, which we name the tubercle bacillus, has lodged in the lungs, and is flourishing there.

Similarly typhoid fever is a condition induced by colonies of the typhoid bacillus in the large intestine; diphtheria means a poisoning of the system by the secretions of a colony of Klebs-Loeffler bacilli in the throat, and so on.

We speak of the microbes that produce these

untoward results as "malignant"; but of course this is a biased view of their activities. The bacilli may cause the death of their host, but it is by no means to their advantage to do so. They have colonized in his lungs or digestive tract or throat because they found lodgment there convenient, and they can multiply and flourish only in a warm place. So if they increase with such ill-judged rapidity as to cause the death of their host, they must presently die also, being powerless to escape.

Instead of malignant, we might better describe these microbes as foolish.

There are sundry wiser members of the tribe that have learned to colonize the human body without being obviously harmful; at least without causing the death of their host. Some fifty different species or varieties of these peaceful microbes may be found on occasion flourishing in the salivary juices of the mouth; and legions of them are always present in the intestinal cavity. Their host, far from being made violently ill by them, is blissfully oblivious of their existence.

And yet these "benevolent" bacteria, no less than the "malignant" ones, are perfectly tangible creatures, of definite size, form, and contour.

If you were to moisten a glass slide with your tongue and place it in the field of a microscope, you might witness the activities of a strange and varied company of fellow-citizens. You would see that some tribes are shaped like tiny rods. These are called bacilli. Others are mere dots,

like infinitesimal droplets of water. These are called micrococci. Yet others resemble tiny cork-screws, and are called spirilla. These are the three main tribes of bacteria, each tribe having many species, which, however, closely resemble one another in general appearance. The largest of them come within the range of vision only when magnified by a powerful lens; and the smallest ones that have been observed are barely visible specks when amplified by a thousand diameters. A man similarly magnified would appear more than a mile in length.

Yet the most infinitesimal microbe, when banded with his fellows, may prove more than a match for the man. Indeed, it almost seems as if the microbic virulence increased with diminishing size; for the malignant varieties are mostly far smaller than many benevolent ones; and the germs of several very malignant diseases, including smallpox, scarlet fever, and hydrophobia, escape detection under the most powerful microscope. They appear to be able to pass through the meshes of a porcelain filter.

Thus they are unthinkably small; yet they are as deadly as cannon balls.

Treacherous Half-Tamed Legions

Among the hosts of "peaceful" microbes that appear in the drop of saliva you have placed on the microscope slide, there may be some that are by no means so harmless as their presence in the

mouth of a person in perfect health might seem to argue.

More than likely there are goodly numbers of pneumococci, the germs of pneumonia; and almost certainly there are hosts of streptcocci and staphylococci, the pus-forming microbes and the agents of blood poisoning. All these may flourish in your mouth without causing you obvious injury or inconvenience. They seem quite friendly and harmless. But in reality they are treacherous ingrates; for, even as they bivouac under a flag of truce on your bodily surfaces, exterior and interior, they are forever on the lookout for an opportunity to invade your blood-stream and lymph-spaces; and when the opportunity comes, they will wage a guerrilla warfare as ruthless as that waged by any one of the frankly hostile bacteria.

Suppose, for instance, that you chance to be exposed to inclement weather some day, and become thoroughly chilled. Your temperature is lowered for the moment; your vitality below par. That moment of weakened defense will quite probably be seized on by the pneumococcus to invade your lungs; and you will be stricken with pneumonia.

Or suppose that a company of diphtheria bacilli find their way into your throat. The hostile colony will at once be agumented by recruits from the ranks of the streptococcus—always loitering in your mouth—who will help to form a characteristic " false membrane," and if possible will invade the tissues, and induce blood poisoning.

Then, too, the streptococci can live on the surface of your body. Doubtless there are myriads of them on the hand with which you hold this book. When a cut or wound, small or large, develops an angry, ulcerated surface, the presence of streptococcus and his allies is demonstrated. In warfare it is not bullets that kill most soldiers, even those that fall wounded on the field. It is streptococcus, and his close relative, staphylococcus, which invade a wound, otherwise perhaps not serious, and produce suppuration and gangrene.

It is these germs that find their way into the blood-stream, causing blood poisoning, and presently completing the deadly work of bullet and bayonet.

Even with no external lesions to give them free access to the tissues, these omnipresent microbes may on occasion find their way into pores or ducts in the skin, causing boils, carbuncles, stys, or local abscesses. In pulmonary tuberculosis they are the chief cause also of the ulcers in the lungs that induce hemorrhage and ultimately death itself. They are a prime, if not the exclusive, cause of erysipelas; and in smallpox and scarlet fever their activities produce complications of serious and very often of fatal character. Wherever they gain entrance, the symptoms of blood poisoning supervene. In one-third of all deaths, from whatever primary cause, streptococci may be found in blood taken from the heart. They may cause a malignant inflammation of the lining membrane

of the heart itself; and they have an active share in hastening the end of patients suffering from diabetes and other supposedly non-bacterial maladies.

First and last, the streptococcus has had a hand in more human deaths, probably, than are to be charged against any other single agency whatsoever.

And all this, be it understood, refers to a microbe that has been said to be semi-domesticated because it is always present everywhere on our skins and in our mouths; however unfamiliar his name may be to his average host.

The Body a Fortified Castle

But if, then, microbes of such malign possibilities are not merely all about us but all over us—on your skin and mine, under our finger nails, in our mouths—how do any of us escape being stricken down by them even for a single day or hour?

The answer gives an insight into strange functions that until recently were quite unsuspected. It reveals the human body as a fortified citadel, guarded at every vulnerable point, without and within, by walls that to the enemy are well-nigh impenetrable; and garrisoned with legions of war-rs ever on the alert to attack any intruder that tes a breach in the fortifications and finds en-ice.

uch language may seem figurative. In reality

it expresses the precise conditions that prevail. The invading hosts have been named, and the character of their onslaught suggested. The barriers that hold them at bay—the walls and barricades of the human fortress—are the skin without and the mucous membranes within the cavities of the body.

The soldiers that stand ready to attack the microbic invaders are the white blood-corpuscles, or leucocytes, that everywhere swarm in the blood- and lymph-channels.

If you were to prick the tip of your finger with a needle, and place the tiny droplet of blood that exudes on a microscope slide, you would see thousands of these leucocytes distributed here and there in the blood, in the midst of the millions of red blood-corpuscles. You might recognize them at once by their relatively large size. They appear practically colorless, like a drop of white of egg; but a visible nucleus shows that they have a definite structure; and the way they move about, slowly changing shape and, as it were, flowing in one direction or another, shows clearly that they are alive. They closely resemble in appearance and manner the lowly single-celled organism called the amœba, which you may have seen under the miscroscope in a drop of impure water; and it is a trifle disconcerting to observe that there are thousands of these creatures in the tiniest drop of normal blood.

But you owe not merely health but life itself to them.

The Battle in the Blood-Stream

If you wish to see for yourself what manner of service the leucocyte performs for you, nothing more is necessary than to insert a needle-point in a culture of bacteria—say, in your own mouth—and convey a colony of microbes to the drop of blood you are examining. It will then be clear that the leucocyte is a creature of ferocious nature, who regards every bacterium as a mortal enemy, which must be fallen upon and literally devoured. You will see the leucocyte flow about the bacteria and engulf them bodily, one after another; and the remains of the victims will be visible within the transparent body of their devourer, until they gradually undergo digestion.

Owing to this extraordinary habit, the leucocytes were christened phagocytes, or cell-eaters, by Professor Elie Metchnikoff, who first witnessed this strange battle in the blood, and interpreted its beneficent meaning.

You might witness such a fight as this not only in a drop of your own blood, but in the living tissues of the web of a frog's foot if touched with an infected needle-point; or, to better advantage, under high powers of the microscope, in the thin mesenteric (intestinal) membrane of an anesthetized mouse.

At first glance the contest will seem an unequal one. The invading bacteria are but pigmies beside the militant defenders. Streptococci are so small, for example, that a regiment of two thou-

sand of them, ranged up in line, would be required to span the letter "o" as printed on this page. The typhoid bacillus would require half an hour's time to cross the same space, though it propelled itself (as its cilia enable it to do) more than three times its own length each second. The influenza bacillus is so infinitesimal that if the warriors of his clan were neatly marshaled in compact order, more than six billion of them could be quartered on the surface of a square inch.

To such Lilliputians, the white blood-corpuscle, about two thousand five hundred of which could span an inch, must seem colossal.

But the bacterium, though outclassed in size, is by no means helpless. The noxious members of the tribe are endowed with some chemical or physical property, the exact nature of which we do not know, that enables them to repel the leucocyte and strangely escape being engulfed in its body. Such at least is often the case.

The cells of the body, however, under stimulus of the presence of a hostile bacterium, can secrete certain chemicals that break down the bacterial defense, and put the microbe at the mercy of the leucocyte.

When such chemicals have been secreted into the blood (or when they have been artificially introduced) the bacteria are weakened, and the leucocytes will be seen, under the microscope, to throw themselves upon the microbes and devour them, ultimately digesting their remains.

The extent to which the leucocytes are able to

do this very largely determines the relative safety of any given individual against the attacks of a microbic host.

Billions of Combatants

The conditions of the fight will be better understood if we reflect that the invading microbes, when they gain entrance to the blood at all, are likely to come in hordes of unthinkable numbers, and are able to reproduce their kind, and thus fill up gaps in their ranks, with appalling rapidity when they find favorable conditions. A baterium born this moment may become a grandparent within an hour. That is to say, it may have divided itself into two individuals, and these two may have divided to make four. And this process may proceed, if conditions continue favorable, with the cumulative speed that renders a geometrical ratio always so startling.

At the end of forty-eight hours, it has been estimated, a single bacterium may have descendants to the number of 281,500,000.

In another day, the number would be beyond computing; but the aggregate bulk of the family —composed of individuals that could lodge by millions on your finger-tip without your knowing of their presence—would be, as Dr. Jordan assure us, more than *seven thousand tons!*

With such figures in mind, we may gain some notion of the task that is cut out for the white blood-corpuscles when a bacterial army invades

their stronghold. The foe may come by billions, though their medium be but a few drops of contaminated water or milk; and it is obvious that no time is to be lost if they are to be prevented from absolutely overwhelming the body by mere force of numbers, to say nothing of the toxic effects of their secretions.

But the defending leucocytes constitute a host of prodigious numbers also. It is evidence of the stressful conditions under which we live that there is a garrison of about one hundred thousand leucocytes at all times in every drop of blood in our bodies.

They constitute a standing army numbering more than fifty billion, in the blood-system of every human being.

The maintenance of such an army, eternally vigilant, is the price of life itself in this microbe-haunted world. There is no hour of the day when the system may not be invaded by one or another of the bacterial hosts that are ever garrisoned on the other side of the thin walls of the skin and mucous membrane.

A mosquito or a flee or a tick or a bedbug may drill a hole through the wall, and introduce a regiment of germs of malaria or plague or contagious fever.

A chance nail puncture may bring deep into the tissues a colony of streptococci or the deadly microbe of tetanus (lockjaw), which abounds almost everywhere in the soil.

A slight fissure in tonsil or pharynx may give

opportunity for the streptococcus and his allies to enter tissues in which they can multiply with astonishing rapidity.

Or the coign of vantage from which the attack is made may lie in a remote lobule of the lung, or in the intestinal tract; such being the favorite seats of action of tubercle and typhoid bacilli, respectively, to name but two enemies among many.

Details of the Combat

So it is absolutely essential that the leucocytes should at all times be posted in numbers, behind every inch of the fortifying but not quite impregnable walls.

It is essential also that they should constitute a mobile army, capable of being concentrated at any given point where an attack of unusual virulence is sustained. The position of the leucocytes as normally distributed throughout the blood-stream enables them to fulfil these conditions ideally. They are always present as a defending garrison about every cell of the entire body; and when any localized attack of microbes is reported, there is an instant reinforcement of the troops at that point supplied from the neighboring blood-channels.

Should there be a cut in the flesh, for example, or a bullet wound, which is "infected," the surrounding tissues become swollen and red—"inflamed," as the saying is.

This means that the blood-vessels have become

patulous, their blood-current slackened, to give lodgment to ever-increasing bands of leucocytes that are being mobilized there to contest every millimeter of the exposed territory with the invading microbes. How recklessly they throw themselves into the breach is shown by the fact that the pus which presently gathers and flows from the wound is composed largely of the bodies of leucocytes that, in their eagerness to pursue the enemy, have, so to speak, fallen outside the broken fortifications.

Until a few years ago, no one understood the nature of this contest. The surgeon regarded inflammation as a necessary part of the process of healing wounds. He talked of "laudable" pus, and was well content if the discharge from a wound was free from the bad odor that might portend the onset of hospital gangrene. But to-day Listerism has changed all that.

Now that the condition is understood, the surgeon knows how to deal with it.

He takes good care to see that no microbes follow in the track of his scalpel. Everything that he uses in an operation has been treated with antiseptics or boiled and steamed in a sterilizer. If he is called to an accident case, in which germs have already invaded a wound, he kills the germs with an antiseptic solution, and dresses the wound with "sterile"—that is to say, germ-free—gauze, to prevent any further invasion. The old-time surgeon unwittingly left the entire treatment of a wound practically in the hands of the

militant leucocytes (though he had no notion that he was doing so); the present-day surgeon shuts out the enemy, and makes the presence of the leucocytic host almost superfluous.

Reinforcements for the Warriors

What the surgeon, dealing with visible lesions, accomplishes with his antiseptics, the physician must undertake in quite another way when called upon to aid the leucocytes in fighting germs that have made their way into the general blood-stream and are swarming perhaps in the juices of every tissue.

For two or three microbes only are antiseptic drugs known that can be given in sufficient quantities to kill the remotely scattered germs, without at the same time killing the patient.

But another way of attacking the problem is to attempt to aid the body in strengthening its normal defenses. In many cases this may be accomplished by developing so-called viruses—antitoxins and vaccines—that are deleterious to specific microbes. These viruses are developed only through use of the specific germs themselves.

The antitoxins, of which the remedy for diphtheria is the best-known example, are secured by inoculating a horse with a liquid in which a culture of diphtheria baccili has been grown. After repeated inoculations, the blood of the horse is found to be charged with an antidote to the diphtheria poison, and a portion of serum from the

blood of the horse constitutes the beneficent remedy which, since its introduction by Dr. Emil von Behring less than twenty years ago, is credited with saving millions of human lives.

In the old days, more than half the diphtheria victims died; in our day the serum saves nine out of ten.

Not fewer than seventy-five thousand lives are thus saved annually in the United States alone.

Of vaccines, the familiar examples are that developed in the body of the cow, and used so effectively against smallpox, and the anti-rabic vaccines used at the Pasteur Institutes. The newest type of vaccine-therapy calls on the individual human patient to develop his own antidotes, and it induces conditions that enable him to do this safely and effectively. The therapist makes a culture of a specific disease-germ in the laboratory test-tube. He then kills the microbes by heating them, and with a hypodermic syringe injects a few million of their bodies into the tissues of the human subject.

Such a wilful inoculation of a patient with virulent disease germs seems at first sight a hazardous experiment.

But the microbes are injected in limited numbers, and, being dead, they cannot add to their number by reproduction. So the tissues are able to cope with them, producing the specific antidotes which neutralize the bacterial poisons and either destroy the bacteria themselves or render them susceptible to the attacks of the leucocytes.

The substance, known only through its effects, that produces the latter result was named "opsonin" (from a Greek word meaning, to make palatable) by its disçoverer, Sir Almroth Wright. A test of the rapidity with which the leucocytes eat any given germs in the blood of a patient—based on an actual count—is called the determination of the "opsonic index." Where opsonin is absent, the leucocytes are inactive; where present the militant defenders launch themselves on the enemy, and devour them with avidity. Any person is immune, or relatively immune, to a given bacterial disease if his opsonic index is high.

If your system contains enough of the opsonins, you are virtually germ-proof.

Wide Scope of the Vaccine Treatment

The utility of the vaccine treatment is not confined to preventive measures. It is now being applied as a curative measure also, after patients are stricken with disease. The utility of the method is particularly obvious in the case of localized infections. Here, let us say, is a focus of tubercle germs in the lungs, or of germs of malignant endocarditis in the lining membrane of the heart. The local tissues fight bravely, but are unable to gain a decisive victory; the unwelcome microbes hold their own, or increase in number. But the vaccine therapist—he is usually termed an immunisator—comes to the rescue, by

injecting into the patient's arm or leg a dead culture of microbes.

This sets up a vigorous local production of antidotes, the excess of which enters into the general blood-stream, finds its way to the local tissues where the fight is going on, and constitutes a reinforcement that may turn the tide of battle.

The vaccine treatment has great popular interest, not only because of results achieved with such deadly maladies as typhoid fever, tuberculosis, and pneumonia, but because it is now being applied by Sir Almroth Wright and his followers to the treatment of a great number of minor ailments which, in their totality, so Sir Almroth contends, make up nine-tenths of human disease.

Common colds, recurrent influenza, sore throat, chronic bronchitis, boils, carbuncles, ulcerated teeth, and even stys and pimples come within the range of the new treatment.

In stubborn cases, the germs used to make the culture are taken from the infected area of the individual patient to be treated, constituting a so-called autogenous virus. Specific or individual treatment is thus carried to its limits.

The results are sometimes very remarkable. When the treatment has come into general use, it will be possible, Dr. Wright believes, to give the average man immunity from the particular type of minor ailment to which he is subject, no less than to give him protection against the attacks of the more virulent microbes.

Coupled with these curative and immunizing

methods is the work of the modern sanitarian, who effects a flank movement of inestimable import by establishing quarantine service, by fumigating infected quarters, and by destroying the living carriers of germs—mosquitoes, flies, ticks, fleas, bedbugs, rats, mice, and ground squirrels. All these measures look to the single end of making life hard for the noxious microbe; and enough has already been accomplished to warrant the prediction that these infinitesimal but all-powerful enemies of our race will play a far less important rôle in the future history of mankind than they have played in the past.

Some Rules for Health

Not to be misled into undervaluing our antagonist, however, it is well to recall that, despite the justly applauded triumphs of modern medicine, microbic diseases still cause the death in the United States of at least one hundred individuals each and every hour of the day, year in and year out.

With such a menace as that confronting us, it may well be asked what any given individual may do to safeguard himself and his family against the universal enemy.

I shall answer the inquiry in the briefest terms, with a few practical suggestions:

Be vaccinated against smallpox. The vaccine virus is developed in the system of a cow or calf. As developed by modern health boards it is free

from contamination, and it gives immunity against a disease that was formerly one of the worst of scourges, claiming one-tenth of the population by death. Have your children vaccinated in infancy, and revaccinated every six or seven years, or whenever there is possibility of infection.

Be inoculated against typhoid fever, if you have occasion to travel in a region where hygiene is not under scientific control, or where for any reason you mistrust the sanitary conditions in general.

Take anti-rabic treatment at the nearest Pasteur Institute, should you have the misfortune to be bitten by a dog or cat suspected of having, or known to have, hydrophobia. The anti-rabic virus is developed in the system of a rabbit. Its efficacy in preventing hydrophobia or rabies is unquestionable; but it is unavailing as a curative measure after the disease has actually manifested itself. Fortunately rabies has a long incubation period, so there is time to take the preventive treatment.

Treat minor wounds, particularly those caused by puncture from a soiled or rusty nail, with respect. Go at once to a doctor and have the wound properly treated. It is foolhardy to take chances with the bacillus of lockjaw.

Have your physician recommend an antiseptic spray or douche for nose and throat. Keep this at hand in an atomizer, and use from time to time, more or less as a matter of toilet routine; but particularly as an added precaution when influ-

enza is epidemic, or when you have been exposed to bad weather or subjected to fatigue.

Never sit down with wet feet or moist apparel. If your stockings have been damp, remove them at once when you get home, and heat the feet thoroughly, toasting them for some time before stove, radiator, or grate. Put on dry clothing, and do not leave the fire until you are thoroughly warm. Also use an antiseptic—say, peroxide of hydrogen—with thoroughness as a mouth wash. The germs of pneumonia sometimes lodge in the mouth without doing harm; but a slight lowering of the bodily temperature may enable them to develop, and, finding their way to the lungs, to set up the inflammatory condition constituting pneumonia, a disease that is responsible for more than a hundred thousand deaths in the United States each year.

Pneumonia has been developed experimentally in fowls by having them stand with their feet in a stream of cold water. You are in similar danger whenever your temperature is lowered for a prolonged period. But the active measures above suggested will usually ward off the danger.

If you are persistently subject to some minor microbic disorder, such as boils, pimples, acute colds, chronic bronchitis, consider the advisability of taking the vaccine treatment to fortify your system against the microbe that is your particular pet aversion. The temperamental condition that makes you especially susceptible to this particular germ may perhaps be overcome in this way. The

condition of the system that leads to the recurrence of boils or to the persistence of open sores and ulcerative lesions, is peculiarly amenable to the vaccine treatment.

Act on the belief that in the last analysis the best protection against the microbes is the rugged condition of your own system. We have seen how the tissues of the body fight any noxious microbes that intrude upon them. Let it be understood that the vigor and efficiency with which the tissues act in this defensive campaign depend very largely upon the healthy tone of the tissues themselves. A ruggedly healthy organism, if not subjected to the depressing effect of overexertion or worriment, may be practically immune to almost every type of microbe.

So all measurements that make for the improvement of general bodily health are germicidal measures.

Eat nourishing food in sufficient quantity, but do not overeat.

Get as much fresh, outdoor air as you can, day and night.

Exercise sufficiently to keep your muscles in tone and your blood in good circulation. Well-toned muscle-cells are practically germ-proof; and an active blood-stream scatters any focus of intruding microbes so widely that the white blood-corpuscles and organic germicides have the best chance to overcome the enemy.

Bathe regularly and rationally, but not to excess. Use tepid or warm water, but end always

with a cold spray or sponge bath, to tone the skin. The cold spray, properly graduated, is a skin-toughener and general tonic of positive value not merely in the prevention, but in the regular treatment of microbic diseases, including in particular tuberculosis.

Avoid the two great depressants, alcohol and worry. These are out-and-out allies of the microbe. Alcohol lowers the tone of the system, decreases the power of resistance, and thus invites microbic diseases. Athletes in training never use it. Arctic explorers have learned that it handicaps them. People in everyday life who wish to maintain maximum efficiency, including maximum resistance to disease, will do well to take a leaf from the experience-book of athlete and explorer.

All these measures look to the combating of the microbic hosts after they actually invade your body. But it is equally the part of wisdom to guard your body as much as may be against needless exposure to attack. However good your defensive armor, you are obviously safest when beyond reach of the enemy's guns. And in particular you should guard your children, whose immaturity makes them peculiarly susceptible, and who cannot guard themselves.

Give the Sunlight a Chance

A prominent channel by which microbes find entrance into our bodies is the air we breathe.

Bacteria exist by millions in every pinch of dust

of the city street; they swarm in the dust that the whole family inhales when the housemaid sweeps or beats a carpet. They settle on bread as it comes from the bakery. We cannot possibly hope to escape ingesting a certain number of them. But there are ways in which we can minimize the number and in large measure avert the danger.

To that end, it should be known to everyone that the one thing which no hostile bacterium can face unflinchingly is sunlight.

The beneficent rays of the sun, which give life to ordinary plant-cells and set them in action, blast the living content of the bacterial cell, like shafts of lightning.

The particular light-beams that have this disastrous effect on the microbe are the short waves beyond the visible spectrum, the so-called ultraviolet rays. Medical science has taken advantage of the knowledge that these rays will kill bacteria, in the treatment of certain local infections. The Finsen-ray lamp, by which the local tubercular disease known as lupus may be cured, utilizes this ultraviolet ray. The newest type of Finsen lamp operates with the quartz lamp invented by Mr. Peter Cooper Hewitt; which lamp, it may be added, is similarly used to purify water and milk, by destroying the contaminating bacteria.

What the Finsen and Hewitt lamps thus accomplish on a small scale is perpetually done in a colossal way by the sun. Whenever sunlight penetrates for any considerable length of time, the bacterial inhabitants are destroyed. If it were

not so—if the bacteria could develop resistance to the sterilizing influence of sunlight—mankind would soon find the contest with the microbe a hopeless battle, and our race would probably disappear from the face of the globe.

There follows the obvious moral: Let there be light in your household wherever and however you can manage it.

Keep your children out in the sunlight.

If you live in the city, utilize the housetops.

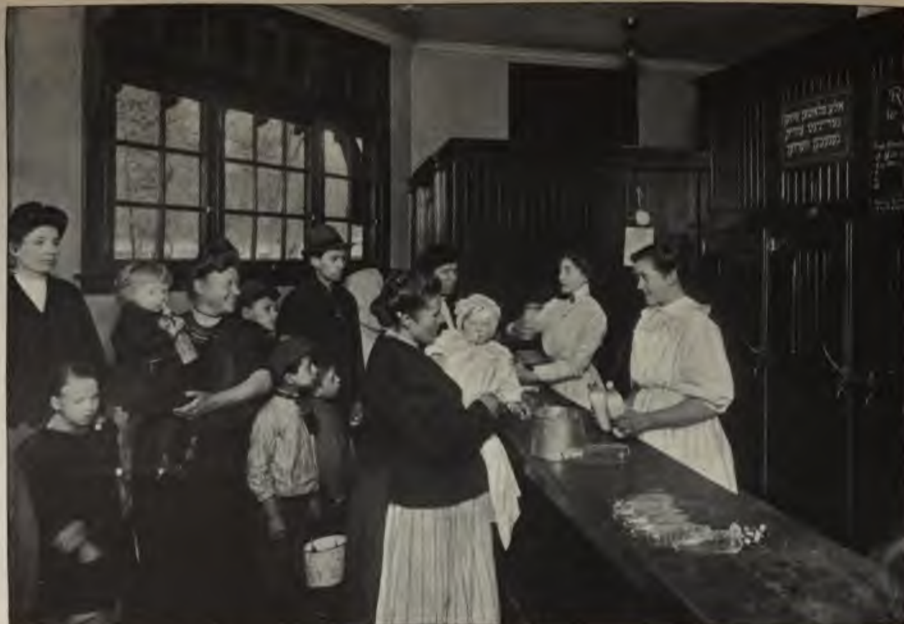
Also let the outdoor air, sterilized by sunlight, into your dwelling day and night. Open-air hospitals cure thousands of advanced cases of tuberculosis. High up in the Alps children are kept naked in the sunlight, out of doors, when the ground is covered with snow. Such heroic treatment must be worked up to gradually, of course; but in the end the children enjoy it; and it cures infections that resist every other remedy.

Open-air treatment in the sunlight, combined with judicious exercise, the toning effect of cool spray-baths, and the right food and plenty of it, will cure almost any case of tuberculosis in its early stages. And the tubercle bacillus is more resistant than most others of the tribe.

Pure Food and Water

Our foodstuffs furnish another obvious medium through which the microbes may be conveyed into our bodies.

Here it is equally obvious that attention to



The milk supply is everywhere under surveillance of health boards nowadays

cleanliness and a few common-sense precautions may go a long way toward thwarting the enemy:

Avoid the grocer who does not protect his wares from flies.

If the water supply is doubtful, boil all drinking water; it may be aerated afterward by pouring from one receptacle to another, that it may not taste flat. Ice that has been stored for months is usually sterile, but not always. Mere freezing for a short time does not kill bacteria.

It is safer to keep the water-pitcher in the ice-box than to put ice in the water.

All other questions that concern germ-infected food are relatively insignificant, however, in comparison with the problem of the milk supply. In the case of infants it is of course the *only* problem. Contaminated milk is the prime source of infection which results in the death in infancy of one-tenth of the human race.

At every third or fourth tick of the clock an infant dies whose death tells of the victory of a bacterial host that should never have been allowed to find its way into the victim's digestive tract.

Of course the milk supply is everywhere under surveillance of health boards nowadays; but the official inspectors must have the co-operation of the public or their efforts are unavailing.

What most people do not understand is that all milk contains bacterial germs. Even before it leaves the udder of the cow, bacteria have found their way to it; others are added in the process of

milking. No health board anywhere pretends to rule that milk sold with its sanction shall be germ-free. That would be a condition impossible to fulfil. All that is done is to limit the permissible number.

But the terms of the regulations are far from reassuring. The city of Boston places the limit at 500,000 bacteria to the cubic centimeter (about fifteen drops). Montclair, New Jersey, after a crusade led by its celebrated surgeon, Dr. J. S. Brown, boasts of a milk supply averaging less than 100,000 germs to the cubic centimeter. In New York City, "certified" milk must contain no more than 30,000 germs to the cubic centimeter, but Dr. Park's investigation showed that milk sold in the shops averaged 300,000 bacteria per cubic centimeter in the coldest weather, about 1,000,000 in cool weather, and 5,000,000 in hot weather.

Drs. Heinemann and Jordan tested market milk in Chicago, the microbe population of which ranged to 74,000,000 per cubic centimeter—about *five million in every drop!*

Such is the beverage with which we feed our babies.

These astounding figures call for explanation. The explanation is simple: milk at ordinary temperature is supremely good food for bacteria. They fairly revel in it, multiplying inordinately. So the presence of vast numbers of bacteria in any given sample of milk does not necessarily impugn the dairy from which the milk came. It

only proves that the milk has been kept for a considerable time, and kept in a warm place.

We have seen something as to the fecundity of bacteria. So it need not surprise us that a sample of milk having 42,000 bacteria in a given quantity when twenty-four hours old, showed 12,200,000 bacteria in the same sample three days later. But we could hardly be prepared for the difference in rapidity with which the same bacteria develop under conditions precisely identical in regard to everything but temperature.

Thus a sample of milk kept at 4 degrees centigrade had 2,500 bacteria per cubic centimeter in twenty-four hours; while another sample of the same milk kept at 13 degrees had developed 18,800 bacteria; and a third sample at 20 degrees showed 45,000. Thus a difference in temperature of only 16 degrees multiplied the growth of the bacteria by about two thousand per cent.

It would appear, then, that if the baby is to be given a reasonably fair deal, it must at the very least be supplied with perfectly fresh milk (which is obviously impossible for the city dweller) or else milk that has been kept at all times at approximately the temperature of ice.

A further element of safety is added if the milk, in addition to being pure and fresh, has been pasteurized. This process consists merely in heating the milk to a temperature of 60 degrees centigrade (140 degrees Fahrenheit) for twenty minutes, and then rapidly cooling it. This does not free the milk absolutely from bacteria, but it does kill the

germs of typhoid fever, dysentery, diphtheria, and tuberculosis, if any of these chance to be present.

The death-rate in an infants' hospital has been known to be reduced by fifty per cent in a single year when pasteurized milk was introduced, even though the milk previously used was fresh milk from a selected herd pastured on the hospital grounds.

In the particular hospital in question, pasteurizing the milk, without any other change in diet or hygiene, is estimated to have saved the lives of 1,243 infants in seven years.

When the average mother learns to give her baby as good a chance as the waifs received in the foundling hospitals, the slaughter of the innocents in the world at large will be proportionately reduced. But we can hardly expect this until the time comes when the average man and woman take as much interest in the battle of the microbes —which vitally concerns their own lives and the lives of their children—as they now take in the bickerings of political parties, the records of scandals and murders, and the warring of Servians, Turks, and Bulgars.

III

Messengers of Death and How to Outwit Them

THE fly that is crawling across the bread-plate there on your dinner table has recently come from a garbage pile, or perhaps from the putrescent carcass of a dog. The reflection is not appetizing, but you know it to be true. There are thousands of bacteria on the body and feet of the fly. Among them are perhaps some germs of typhoid fever or dysentery or tuberculosis.

You are quite aware of this, yet you tolerate the fly, and run the needless risk of becoming its victim.

Nor is the fly the only disease-carrier that invades your household more or less through your negligence or indifference. Observe, for example, that your dog is scratching himself. You know that he is pestered by fleas, and the thought gives you no great concern. But suppose that these fleas chance to have come to the dog from the body of a rat that is infected with the plague. Suppose, then, that one of the tiny acrobats springs to the body of your child as it plays with the dog. As a sequel, the child may presently develop a mysterious and fatal illness, and the malady may spread till every member of your household is stricken.

"The thing is utterly impossible," you say. On the contrary, it lies well within the possibilities.

You must have read not long ago of the finding of a plague-infected rat at New Orleans and another at Philadelphia. Where one or two such rats are captured, there may very well be hundreds that escape detection. Indeed, it would be absurd to suppose that the health authorities have captured the only infected specimens. Nor can we suppose that the two ports named are the only ones at which infected rats have entered. Once ashore, the rat can travel fast and far in freight cars, so he may readily invade the interior of the country.

And it is through the agency of the flea that the virulent disease to which the rat is subject may be transmitted to man.

The Plague at Our Doors

It was with reference to this disease, and to the necessity of ridding the country of the rats and fleas that transmit it, that the *Journal of the American Medical Association* recently uttered this warning:

"The sooner the country realizes that it is face to face with a most serious problem, the better it will be for the lives of the people, and also for commerce."

This most authoritative organ of the medical profession in America urges that the danger is

imminent, and that it will be greatly enhanced when the opening of the Panama Canal brings an influx of ships from the western coast of South America to our ports.

The disease in question is known as bubonic plague. It is a disease with a history. When it swept across Europe in the Middle Ages, it devastated entire populations and it was remembered in aftertime as the "Black Death," or the "Great Mortality."

In a single epidemic, in 1348-1349, it is estimated to have claimed twenty-five million victims, about one-fourth of the entire population of Europe.

The epidemic of 1665 caused 70,000 deaths in London, and drove the survivors to the open fields outside the city.

All this you have doubtless heard; but it seems remote and impersonal. You know that in those old days the streets of a city were filled with refuse, seeming to invite disease; and if you have given the matter a thought you have assumed that there could be no possible repetition of such disastrous epidemics in our sanitary age.

Be advised, then, that recent discoveries tend to disturb the composure with which hitherto most people have contemplated the records of the Black Death. It is now known that the disease has no direct connection with filthy or unsanitary conditions; that its cause is a particular bacillus which flourishes in the system of the common house rat, and which may be transmitted from rat to rat, or

from this host to a human being, by that familiar pest, the flea.

Therefore, any region where the rat is found may be subject to invasion by the plague,—for the rat is almost never without its insect parasite. So the matter comes directly home to you and to me.

The false security in which we have rested has been due to the fact that there has been no severe epidemic of the plague in Europe for more than a hundred years.

It is not quite clear why there should have been such long intervals of quiescence. But there is abundant evidence that an epidemic is now impending, which, if it is not combated, might readily rival the historic outbreaks that have made the name so dreaded. About fifteen years ago the disease began to spread from an infection centre in China. In 1893 it appeared in Hongkong, and in 1896 in Bombay.

In the ten succeeding years it caused about six million deaths in India.

Then the disease began to crop out in the western hemisphere; first at Santoz, Brazil, in 1899; then at San Francisco.

By this time the investigations of the British Plague Commission in India had established the manner of transmission of the disease. It was shown that infected rats might transmit the disease from port to port, even though no human passenger on the ship became infected. So war was raged on the rats by the health authorities in

San Francisco. More than a million were killed in 1907, and many were found to be infected with the plague bacillus. The disease was spread, through the agency of fleas, from rats to the ground squirrel; and in a few cases, through the same agency, to man.

The strenuous warfare on the rats prevented anything like a general epidemic, however; and the same vigilance at other ports in the United States, as well as in Europe, Australia, and Japan, has been similarly rewarded. But the plague has very recently gained a foothold in Porto Rico and in Cuba, where a few deaths occurred in the summer of 1912, leading to an immediate reinforcement of the rat-killing squad of the Health Department. The acuteness of the danger is now emphasized by the finding of infected rats in our eastern seaports.

Of course, health officers everywhere are on the *qui vive*, and the world-wide systematic attack on the rat cannot fail of some results.

Concrete wharves and buildings with cement foundations are making life less easy for the rodents. In some regions, as the Panama Canal zone, houses are built on pillars of concrete, or on posts with inverted metal shields at top, in imitation of the familiar expedient by which farmers protect their corn cribs against the same pests. Ships in tropical ports are sometimes required to have rat guards on all ropes or hawsers reaching ashore.

But all these measures must be supplemented

with the co-operation of householders in general if the desired extermination of the rat is to be effected. And until we are well rid of these prolific little rodents we shall never be quite free from danger of a world-wide visitation of the "Black Death," for it is obviously impossible to eradicate the flea except through the destruction of its host.

Here, then, is a task of the utmost importance in which almost everyone can lend a hand.

Mosquitoes and Malaria

"An interposition of Almighty God provoked by the sins of man" is the way in which a seventeenth century writer refers to the plague. The twentieth century discovery that the agent of transmission is really an insignificant insect is one of the important items of new knowledge through which our entire conception of the spread of epidemics is being revolutionized.

Of course, it has been known for some time that most diseases are due to definite germs; that you can no more have consumption or typhoid fever or diphtheria unless the germs of these diseases are sown in your system than the farmer can raise crops of wheat or corn or rye without sowing these grains on his soil.

But it is only within the past few years that we are beginning to get a clear notion as to the way in which the transfer of germs from one human being to another is carried on.

It is now clear that there are many kinds of germs which do not float in the air, to be disseminated by every chance breeze, but which must be carried from person to person as definitely as grain is carried to the field by the farmer.

There are even germs, particularly those of animal nature (so-called protozoa,—to be distinguished from the bacteria, which are classified in the vegetable kingdom), that depend for their existence upon the good offices of a particular type of insect, and must perish as a race if that insect is not at hand.

As the best-known example, take the case of the microscopic protozoal organism, called a *Plasmodium*, that is the sole cause of malaria.

This pestiferous microbe leads a double life in a very literal sense. At one prolonged stage of its history it maintains a celibate existence, lodging in the red blood-corpuscles of the human body, and multiplying solely through the formation of spore-like divisions of its substance. The setting free of a generation of spores ("merozoites" they are called) coincides with the onset of the characteristic chill that marks the disease.

The germ thus makes its human host most uncomfortable, and even causes the death of many thousands of individuals each year; yet the plasmodium itself does not come to its own, so to speak, so long as it remains in the human system. It completes its life-cycle only when sucked into the stomach of a mosquito.

Nor can any and every mosquito serve the pur-

pose: it is only mosquitoes of the genus *Anopheles* that can serve as host.

But in the system of this particular insect, the plasmodium takes on a new lease and a new manner of life, multiplying sexually, and developing a generation of offspring that will lodge in the salivary glands of their host, thence to be transmitted to any human subject that the mosquito chances to assail.

Such being the life history of the malaria germ, it follows that by destroying this particular type of mosquito we should eliminate the plasmodium race and rid mankind of the widely prevalent disease malaria.

You may reside if you wish on the borders of the most "miasmatic" swamp; wade in or imbibe its waters; breathe its air day and night—and there is not the remotest chance that you will be stricken with malaria so long as you are guarded against the attacks of the mosquitoes of the genus *Anopheles*. Such is the accepted and demonstrated fact to-day.

The ferreting out of the secret was chiefly done by Dr. Ronald Ross, of the British Army in India, as recently as 1897. Subsequent practical experiments of Drs. Rignami in Rome and Manson in London were required to overcome the incredulity of the medical profession.

The suggestion that a mosquito may play this extraordinary rôle had indeed been made some years earlier by the American physician, Dr. A. F. A. King; but proof was not then forthcoming

and the suggestion was ignored or openly discredited.

Now that the facts are known, every community should think it worth while to rid itself of these pests, by curtailing their breeding places. You can do your share by pouring kerosene on the surface of any stagnant pool in your neighborhood. You should also see that no gutters or rain barrels or other receptacles of water are permitted to remain uncovered.

Even an old tin can may offer a breeding place from which myriads of malaria-carriers will come forth.

The Yellow Fever Mosquito

Proof that the mosquito is the carrier of the germs of malaria served to give a new aspect of plausibility to a theory first put forward by Dr. Nott of New Orleans as long ago as 1848, and prominently advocated by Dr. Charles J. Finlay of Havana in 1881, to the effect that the virulent disease yellow fever is also transmitted by a mosquito.

At the time when the American authorities set about renovating Havana, no one took much stock in the theory, except Dr. Finlay. It seemed clear enough to all other observers that yellow fever is transmitted through the air, or at least through the medium of clothing, bedding, and the like.

But Dr. Finlay's insistence led to an official test of his unlikely theory, under direction of a Com-

mission comprising the U. S. Army surgeons, Drs. Reed, Carroll, Agramonte, and Lazear,—the last named of whom, it should not be forgotten, lost his life in the course of the experimental investigation.

Many lives were hazarded. It could not be otherwise, because the germ of yellow fever had not been isolated, hence microscopic tests, such as were used with the parasite of malaria, could not be employed. It was necessary to expose human beings to the conditions of infection, and await results.

Volunteers from among the American soldiers quartered in Cuba were not wanting. The members of one group were confined in rooms contaminated with the effects of victims of yellow fever; subject to the usual supposed channels of infection, but rigidly guarded against the attacks of mosquitoes by the careful screening of their quarters. These men remained free from disease.

Members of another group were kept away from all contaminating surroundings, but were allowed to be bitten by mosquitoes that had had access to yellow fever patients. Six out of seven of these men promptly developed the fever.

The tests were so definite as to remove all doubt. The carrier of yellow fever was found to be a mosquito of the genus *Stegomyia.* When this mosquito is eliminated or excluded, yellow fever disappears. Abundant proof of this has been given in Cuba, and also in the Panama Canal zone. In the latter region, under the able supervision of

Colonel Gorgas, the draining of pools and the netting of porches and windows resulted in transforming a pest-ridden zone into a place of salubrity and health.

No such transformation, perhaps, was ever before or elsewhere effected in so short a time and as the direct result of a new and unexpected scientific discovery.

The Typhoid Fly

The trenchant if inelegant slogan "Swat the fly!" has become so familiar that one is likely to forget how recent is the discovery that the fly has an important share in the transmission of disease.

It is only a few years since this possible source of contagion was utterly unheeded, even by the medical profession. As recently as 1898 our soldiers in the Cuban War were permitted to die by hundreds of typhoid fever because no one thought to take the precaution to render the dejecta of infected persons innocuous or to put infected matter beyond the reach of flies.

And so, as has been said, the common house fly rather than Spanish bullets was responsible for the chief mortality in our Cuban army. But the like of this will not occur in any warfare of the future; for the insect has now been re-christened the "typhoid fly," and everyone realizes what danger may attend its visitations.

The re-christening was due, I believe, to Dr. L. O. Howard, our expert Government Entomologist,

who has done more than anyone else to call public attention to the history of this familiar but little understood insect. The new name is highly appropriate, in that it serves to call attention to a chief danger with which the insect menaces us. It should be understood, however, that the fly is not the host of the typhoid bacillus in the sense in which the *Anopheles* mosquito is the host of the germ of malaria.

The fly becomes an involuntary carrier of disease germs merely through accidental contamination of its feet or wings or body or buccal apparatus.

It transfers quite impartially any germs that chance to adhere to it.

Microscopic examination has shown that millions of bacteria may sometimes be found on the body of a single fly. Ordinarily, these are of more or less innocuous species. That typhoid germs are sometimes among the number is merely due to the filth-frequenting habits of the insect. The germs of tuberculosis are also susceptible of conveyance; likewise those of diphtheria and cholera. Professor Nuttall has shown that the fly may not only ingest the germs of bubonic plague, but may itself fall victim to the disease.

The best protection against danger from the fly would obviously be found in extermination of the insects themselves. But this offers tremendous difficulties.

A single fly that finds access to refuse heap or garbage pail may deposit a complement of about

120 eggs that will hatch to maggots in five days, and appear as adult flies in five days more. The life-cycle is so short, the fecundity of the insect so great, that the progeny of a single female in a summer season would if unrestrained reach unbelievable numbers.

Here are the figures, according to someone who has taken the trouble to make the computation: 1,096,181,249,311,720,000,000,000,000.

When we reflect that (estimating 10,000 flies to the quart) this would represent about 340 *billion bushels* of flies for each man, woman, and child in the United States, it would appear that the outlook for a fly-catching crusade of extermination is not encouraging.

And the matter seems quite disheartening when the computer further assures us that if food and breeding places were provided and enemies evaded, the progeny of a single fly in unchecked development through twelve generations may be estimated as making a mass of flies measuring 268,778,165,861 cubic miles, or considerably more than the total size of the earth.

In the light of such figures, fly "swatting," though commendable enough in itself, must seem an inadequate method of extermination.

But fortunately more effective measures are available. A recent editorial in the *Medical Record,* from which some of the figures just given are quoted, suggests the slogan "No filth, no flies —and no disease." It urges that we follow the fly to her breeding place—seldom more than 300 to

500 feet away—and make that place decent and sanitary. We are told that we must get rid of "the unsanitary closet, the manure heap, the uncovered garbage can, the putrescent dead dog and horse in the public highway. All refuse and decaying material and all vegetable and table waste should be removed and be burned or covered with lime or kerosene oil. Stable manure should be put into tight pits or vaults; a barrel of chloride of lime to be constantly at hand, from which each deposit of manure should be sprinkled."

If every citizen would constitute himself a committee of one to help carry out such a reform as this, we should soon abate the fly nuisance; and thousands of human lives would be saved that are now needlessly sacrificed. But the co-operation of each and every individual is absolutely essential. One family that is careless about the disposal of garbage can breed more flies than an entire community can kill.

The very least you can do is to make sure that you are not guilty of such a crime against your neighbor.

Ticks and Other Creepers

It is only a few years since English text-books in use in the schools—seeking to carry out the old delusive idea that everything must be of value to man—conveyed the edifying information that "the fly keeps the warm air pure and wholesome by its swift and zigzag flight."

I presume this antediluvian conceit is now sup-

pressed; but one may still hear the fly defended on occasion—and somewhat less farcically—as a scavenger. There are sundry creeping suctorial insects, however, that so far as I know have never found an apologist—except possibly on the ground of being provided to test man's temper and endurance.

Of this unwholesome company are the ticks of various species. These obscure creepers are known to have importance as germ-carriers, largely in connection with tropical diseases of cattle. They jeopardize the pocketbook, if not the life, of the American farmer; for the virulent cattle disease known as Texas fever, which costs our cattle-raisers many hundred thousand dollars annually, is due to a protozoal germ that is transmitted solely, so far as is known, by ticks.

An interesting feature of the matter is that the germs are not directly transmitted from one beef creature to another by any individual tick. The insect, having taken its fill of blood, drops to the ground, and there deposits its eggs. The young that come from these eggs make their way to the bodies of other cattle, and inoculate them with germs acquired in this curious congenital fashion.

Thus cattle may acquire the disease by grazing in an "infected" pasture, without coming in contact with any infected animal.

To prevent the possibility of such infection, it is customary before shipping cattle from the "fever zone" to make them swim through a tank of petroleum, which kills the ticks.

These curious facts have double interest because they were first demonstrated by two American investigators, Drs. Smith and Kilborne, who thereby proved for the first time that a protozoal disease may be transmitted by a blood-sucking insect. A new era in medicine dates from that discovery, made in 1898.

An early result of the new knowledge was to cast suspicion on the familiar wood-tick as a possible carrier of disease. It was suggested by Drs. Wilson and Chowning, and demonstrated presently by Dr. H. T. Rickets, that the wood-tick is the carrier of the very fatal malady known as Rocky Mountain spotted fever.

In Montana this disease is much dreaded, inasmuch as it causes the death of about seventy per cent of the persons who become infected.

Our knowledge of the disease is largely due to the investigations of medical officers of the U. S. Public Health and Marine Hospital Service. One of these, Dr. T. B. McClintic, himself fell victim to the disease, adding his name to the already long list of martyrs in the cause of science.

The newspaper reports of Dr. McClintic's death (which occurred August 13, 1912), and of the Congressional bill for the relief of his widow introduced by Senator Myers, of Montana, gave the general public its first knowledge of Rocky Mountain fever, which has hitherto been prevalent chiefly in Montana, Idaho, and Nevada. It should be understood, however, that there seems no reason why the disease should not invade any region

of the country to which infected ticks chanced to be conveyed; so the effort to eliminate the ticks, in which Dr. McClintic lost his life, is an enterprise having first-hand interest for all of us.

The Fly that Carries Sleeping Sickness

Very recently Dr. G. H. F. Nuttall, the American Professor of Biology at Cambridge University, has made an exhaustive study of the entire tribe of ticks, with reference to their germ-carrying habits.

He finds that the insects play an all-important rôle in the spread of various allied protozoal animal diseases of the Tropics.

In at least one case a protozoal germ closely similar to those that cause the cattle fevers may flourish in the blood of man, causing the deadly malady known as "sleeping sickness." The agent of transmission here, however, is not a tick but a small winged insect called the tsetse fly. Unlike the typhoid fly, this insect bites through the skin and sucks the blood, and thus may transfer the germ of sleeping sickness (called a *Trypanosome*) from one human subject to another.

Sleeping sickness is confined to the tropical regions of Africa, presumably because of the tsetse fly's restricted habitat; but it is so prevalent and virulent a plague that entire regions are sometimes depopulated owing to its ravages.

The disease has spread over new areas in recent years. It is estimated to have caused in the neigh-

borhood of half a million deaths among the natives of the Congo region in the decade 1896-1905. In some regions of Senegambia, from 30 to 50 per cent. of the population of a village are found to be infected; and infection in this case means sure death.

Persistent efforts have been made, particularly by Professor Ehrlich, to find a remedy that will cure sleeping sickness, but with doubtful success. To be bitten by an infected tsetse fly is to receive a death sentence that cannot be evaded. Even should a remedy be found that will cure the disease, this would obviously be only a tentative measure.

Nothing short of the extermination of the tsetse fly itself can make civilization possible in the regions it now frequents.

The undoubted fact that progress is thus held in check by a tiny insect may be pondered in connection with Dr. Ross's suggestion that the decadence of civilization in ancient Greece may have been due to the encroachments of the malaria-transmitting mosquito.

Who until very recently suspected such influences as these in history? Who would have dared suggest that the proboscis of a tiny insect may be mightier than sword or pen? Yet the validity of such a claim becomes increasingly evident as we study the recent discoveries in relation to the transmission of disease. In the light of what is now known, it is not too much to assert that insects of two or three species have undoubtedly been re-

sponsible for more human deaths in modern Europe than all the implements of warfare that man has devised.

As to venomous serpents and savage beasts, their entire toll of human lives since history began is a negligible quantity in comparison.

The Ubiquitous Bedbug

It is not unlikely that the worst offender of all is an insect that until very recently has scarcely been under suspicion. I refer to that most unpopular of creeping things, an object of abhorrence to every conscientious housewife, which the squeemish writer commonly refers to as *Cimex lectularius,* but which may best be unmasked under its plain every-day name of bedbug.

The case against this familiar if unwelcome co-resident with man is convincing and utterly condemnatory. It has been shown by Dr. Patton, of the Indian Medical Service, that the fatal tropical disease known as "kala-azar" may be transmitted by the bite of the bedbug; and the Russian investigator, Dr. D. T. Verjbitski, has demonstrated conclusively that this insect may transmit the germs of the bubonic plague quite as effectively as does the flea.

Not only may the insect transmit the germs directly in biting; but on linen soiled by the insects or contaminated by their crushed bodies the plague germs may retain life and virulence for a term of at least five months.

Of this discovery, Dr. J. V. Manning, writing recently in the *Medical Record*, says that to the student of preventive medicine "Verjbitski's demonstration that bedbugs transmit blood-borne diseases is the most revolutionary discovery made since Pasteur announced the etiology of anthrax. This illuminating thesis lightens the path along which science has floundered in search of the common mode of transmission of acute epidemic disease. It would appear that any disease whose germ or virus is liberated in the blood at any stage of the attack may be transmitted by the ubiquitous bedbug."

Among the common disease specifically named as probably transmissible by this insect are infantile paralysis, measles, smallpox, and scarlet fever. A complete list would probably include, as Dr. Manning suggests, practically every infectious blood disease.

Bearing this in mind, and considering the habits of the bedbug, it seems not unlikely that this insect may be the most important of all agencies for the spread of epidemic diseases, particularly in the tenement regions of cities. Hiding in the cracks and crevices, and passing from one apartment to another, the insects may very well be supposed to carry the germs of infection—as of infantile paralysis or measles or diphtheria—from one family to another throughout a crowded block.

Nor must we overlook the extent to which the insect may effect involuntary migrations from one social stratum to another.

Unwelcome as the thought may be, it is true that there is a constant distribution, and that the insect may gain access to the best-regulated household in spite of every reasonable precaution, as a recent Bulletin of the U. S. Entomological Bureau has declared.

Says Dr. Manning: "The physician returns from the slum case and the lawyer from the court where bedbugs swarm; the maid takes her half-day in a tenement home, the daily paper is distributed by a tenement dweller, the hand laundry often returns from a tenement district; the vacation is spent in unfumigated summer camps, and the traveler's bag or trunk is a usual hiding-place for Cimex; men, women, and children of all social classes come in close contact in railroad stations, transit lines, theatres, schools, moving picture entertainments, summer amusements, and public inns."

Hence the possible invasion of every home by the "retiring but ubiquitous bedbug."

All of which makes very unpleasant reading, but is pre-eminently important because it brings to mind a vivid picture of dangers to which everyone is more or less subject, but which until very recently no one had suspected.

Of course, the remedy suggests itself: the bedbug must be eliminated, just as the mosquito, the fly, and the flea-laden rat must be eliminated, in the interests of public health.

But how is the feat to be accomplished?

Undoubtedly the task presents difficulties of no

common order. Tentative measures are familiar to every housewife. But efforts of a more comprehensive character are necessary; and the matter is so important that the U. S. Bureau of Entomology has recently issued a Bulletin telling in detail how to fumigate a house with hydrocyanic acid gas, which will penetrate to the remotest crevices and destroy every living thing. Measures so heroic are obviously for the use of Health Officers, not for private individuals; but a full recognition of the dangers to which *Cimex lectularius* subjects us will lead citizens in general to co-operate with the authorities in exterminating this deadly pest.

IV

Is Your Brain All Right?

NOT long ago a novel attraction held the attention for an entire week of thousands of visitors at the College of the City of New York. It was called the Mental Hygiene Conference and Exhibit. Nothing like it had ever previously been seen anywhere in the world. It had to do with a subject that most people have never given a thought, yet a subject of paramount importance to all of us—the question of conserving mental health and efficiency; your mental health and mine, and the mental health of our children.

It is safe to say that a majority of the thousands who visited the exhibition learned more in a half hour about the brain and mind; about mental health and mental aberration; about ministering to the mind diseased and training the normal mind, than they had ever known before.

As Dr. Stewart Paton, of Princeton, who prepared the main exhibit, has said, the display seemed to bring home to many observers with the force of a new discovery the fact that human beings have brains.

That was a timely revelation. We have all learned a great deal in recent years about the care of the body; about the prevention and cure of

physical diseases. It is time, then, that we should be made to realize that even the most robust physical health is not worth having unless mental health—which is equivalent to health of brain—goes with it.

The novel exhibit which emphasized this lesson by mechanism and picture and diagram was prepared under the auspices of a remarkable organization called the National Committee for Mental Hygiene. The conference feature, involving the discussion of a wide range of cognate topics by distinguished authorities, owed its success in large measure to the efforts of Mr. Everett S. Elwood, executive secretary of the Committee on Mental Hygiene of the State Charities Aid Association of New York.

The movement thus inaugurated is part of a general campaign of the National Committee for Mental Hygiene, designed, in the words of the president of the organization, Dr. Lewellys F. Barker, of Johns Hopkins, "to secure human brains so naturally endowed and so nurtured that people will think better, feel better, and act better than they do now." The Committee having this ambitious aim has a membership that includes college and university presidents, from Massachusetts to California, noted clergymen, Protestant and Catholic; distinguished medical specialists, superintendents of hospitals for the insane, and a number of well-known business men and social reformers.

Notwithstanding its distinguished personnel,

however, perhaps nothing else about the organization is more remarkable than the story of its origin.

The Origin of the Movement

The National Committee, which has so soon attained national standing and importance, is the direct outgrowth of the efforts of a single individual. Its founder is Mr. Clifford W. Beers, a Yale graduate who had the misfortune while still a young man to suffer a prolonged mental illness that led to his confinement for a period of more than three years in hospitals for the insane. His varied experiences there—of which he retains a very vivid and detailed recollection—led him, after his recovery and restoration to normal society, to take up a crusade for the betterment of asylum management, and in particular for the prevention of insanity.

So clearly and cogently did he relate his experiences, and so sanely did he suggest remedies, that he was able to gain the attention of such men as the late Professor William James and the Hon. Joseph Choate, who urged him to write out his story. He did so; the result being published as a book under title of *A Mind That Found Itself*.

Professor James pronounced the book "irreproachable in style, in temper, and in good taste; fit to remain in literature as a classic account 'from within' of an insane person's psychology; —a narrative of absorbing interest which reads like fiction but is not fiction."

Professor Thomas R. Lounsbury, who also read the manuscript, characterized it as a well-told human document having interest " far exceeding that of any novel that I have read in a long, long time."

President Schurman, of Cornell, described it as a wonderful volume, showing literary gifts which, curiously enough, might never have come to light but for the author's almost tragic experiences. " A hospital for the insane," he declared, " is the last place in the world one would have selected as a school of liberal culture, yet in Mr. Beers' case it meant a good deal more for literary development than a college does for the generality of students."

Such a narrative naturally brought the story and the ideas that grew out of it to the attention of a wide public. Expressions of sympathy and approval from the most varied quarters sustained Mr. Beers in the determination to put his plans for the betterment of the insane, and in particular for the prevention of insanity, into practical operation. He sought and received the co-operation of leading publicists, and the National Committee for Mental Hygiene came into being.

The new organization, despite its distinguished personnel, started out in the most modest way imaginable. It had no funds, no abiding place, no set programme—only enthusiasm and an idea. But in due course a philanthropic gentleman, who desires for the present to be nameless, placed fifty thousand dollars at its disposal, enabling it

to acquire a local habitation and take on more aggressive activities.

With Dr. Thomas W. Salmon as director of special studies, and under the secretaryship of Mr. Beers himself, active work is now in progress at the New York headquarters of the Committee.

Thus the movement which had its inception in the mental sufferings of a patient in the wards of a hospital for the insane has been fairly launched on a nation-wide campaign that promises to be of the utmost benefit, not only to the insane, but to our race as a whole; by "arousing the public conscience" in regard to insane dependents, as Professor James put it; by enabling many a wavering mind to "find itself," and by pointing the way to higher standards of mental efficiency for all of us.

The Need of Better Brains

Dr. Barker names as first among the objects of the organization, "the protection of the mental health of the public at large."

Probably it has never occurred to most of us that our mental health is in need of protection; but that is largely because we are mostly oblivious to a matter that concerns us more vitally than any other.

If we gave the subject attention, a good many of us would discover that some rules for mental hygiene might not be amiss for us.

How many of us, for instance, are entitled to feel that our mental efficiency is fully at par? The

generality of us, if quite candid with ourselves, must admit that our memories are not as precise and retentive in their records as we could wish; that our capacity for concentration leaves a good deal to be desired; and that our powers of will are more or less vacillating and on the whole ineffective.

A good many of us have habits of thought that are positively slovenly.

We slur over what we read in such fashion that we have no precise and really usuable knowledge of it—overlooking essential names, forgetting important dates, remembering the facts of an argument only vaguely and doubtfully.

You pore over your morning paper at the breakfast table, reading of a war in the near East, of a scientific discovery in Germany, of the findings of a Congressional investigation committee, and the like. You are interested and wish to remember what you read. But suppose you were called on at the dinner table to give a clear résumé of the morning's news, noting essentials and omitting the non-essentials; stating names and dates; giving a clear, logical consecutive account of what is important. Could you perform the task in a manner to satisfy yourself or your hearers? If not, your brain is not the well-trained, dependable apparatus of mind that it should be.

Apply the same test to the interesting lecture you heard only last night, or to the book you read last week, and you get the same result. Of all that you read or listened to with so much interest, only

a hazy shadow remains as a part of your mental equipment.

Similarly in the course of the business operations, trifling or important, that enter into your work. You are forever suffering from tricks of memory, faulty decisions of judgment, vacillations of will, and false inferences from perfectly clear data.

You forget to mail your wife's letter; fail to do the promised errand; overlook an appointment; fritter away your time at your desk.

Your mind becomes vague and fatigued after an amount of work that should have served merely as a stimulus. You allow your attention to be distracted by incidental noises.

You are worried over trifles, bemoan mistakes that are beyond repair; give way to bursts of temper that are more mind racking than any amount of legitimate work; and finally end the day with a feeling that you have not really accomplished half that you set out to do.

All of which shows that your brain is not the well-geared, well-ordered, trained and disciplined mechanism that it might be.

And this is so, largely because it has never occurred to you that mental efficiency is in the last analysis the foundation of all efficiency; that mental hygiene and mind training are vastly more important than physical hygiene and bodily training.

More than likely you supplement these sins of omission with habits that directly tend to vitiate

the power or the quality of your mental actions. You smoke far more than is good for your mind and body, charging your system with the nerve-poison nicotine; or you steadily impair your brain power and subject yourself to the danger of permanent mental deterioration by habitually taking alcoholic beverages.

You know, probably, that tobacco is injurious to you; yet you cannot forego the gratification of your senses even for the sake of attaining clearness of mind.

You have probably been told that scientific tests have proved that alcohol, even in small quantities,—a bottle of beer, a glass of wine, a cocktail or highball,—definitely and measurably decreases the amount and quality of mental action. Your observation tells you that a drink of liquor tends to flush your face and momentarily to exhilarate your mind. You might correctly infer that your brain is similarly flushed and that the abnormal activity excited must result in quick reaction. Thousands of observations prove that such excitation, due to alcohol, if persistently repeated, may result in hardening of the arteries, with the attending liability to rupture or the formation of clots, to be followed by the degeneration of the brain tissues.

Yet you prefer to take this chance rather than deny yourself the transient and illusory sense of well-being that a drink of liquor gives you.

If you chance to inherit some measure of neurotic taint (and few families are totally free

from it), or if you are subjected to some undue strain from business worries or an acute illness, the incipient weakening of your brain tissues from the habitual use of alcohol—even in small quantities—will supply precisely the conditions best suited to put you in danger of complete mental breakdown.

Such, indeed, is the history of at least one in four among all the unfortunates who suffer mental overthrow, and are taken to hospitals for the insane. But even short of this, there is the persistent lessening of your mental efficiency which must enter largely into the question of your success or failure in your life work.

All of which suggests that the task of "protecting the mental health of the public at large" is an undertaking that need not languish for want of objects of attention.

From Madhouse to Hospital

Of course you feel very confident that however much your brain may lack of full efficiency or action, there is no probability that it could altogether fail you.

You may be right; yet it is worth your while to recall that there are 200,000 individuals confined in institutions for the insane in the United States to-day, who a few years ago, felt about themselves precisely as you feel about yourself now. Certainly 50,000, perhaps 75,000, of these unfortunates, owe their mental illness wholly or

in part to habits of alcoholic indulgences that at one time were doubtless thought by them to be as harmless as your use of alcohol " in moderation " seems to you now.

Causes aside, however, the ever increasing company of insane dependents may well excite solicitude, and questions of ameliorating their conditions have strong appeal.

Even if no question of humanitarianism were involved, the taxpayer cannot overlook the fact that the monetary cost of the care of such insane as are public charges, added to the loss through their removal from the ranks of productive workers, has been computed at not less than $164,000,000 annually.

The needs of the asylum population vary with different regions. In more advanced communities what perhaps is most needed is the enlightenment of the public as to the excellent conditions that prevail in the institutions for the insane. As to these, there has been a great change for the better within recent decades. Indeed, throughout the past century there has been an unceasing movement in the right direction. Only a little over a century has elapsed since the very first reforms of Benjamin Rush in America, of Pinel in France, and of Tuke in England, emancipated the " lunatic " from chains and dungeons.

The present-day " hospital for the insane " is an utterly metamorphosed institution, as contrasted with the " lunatic asylum " or " madhouse " of even fifty years ago.

The visitor to the modern hospital for the insane will see no padded cells, no patients in manacles, no strait-jackets even. At worst there may be found an occasional patient, suffering from an extreme form of maniacal exaltation, whose perverted activities are restrained by the firm but kindly hands of attendants, or who is subjected to the soothing influence of a prolonged bath.

For the rest, the major part of the patients will be found occupying themselves in a manner not dissimilar to the activities of normal life.

Some are at work, some at play; others are reading or conversing. In the quieter or convalescent wards, the general aspect of things will be that of a hotel or drawing-room rather than of the traditional institution for the insane. And there are sure to be many patients there whose mental infirmity has not deprived them of the ability to converse on a wide variety of topics with entire sanity, with full intelligence, and even with brilliancy. For the mind diseased is a far more subtle mechanism than the average layman supposes, and its derangements are not always paraded with such obviousness that the casual inspector may observe them.

But there are many communities in the United States where utterly different conditions prevail. Only a few years ago reformers in Maryland found that in many regions the insane, in charge of local commissioners, were secluded in cells, and even manacled, quite after the method of the

traditional—and actual—madhouse of medieval times.

In some places the sexes were permitted to associate indiscriminately, and the birth of illegitimate children with a double heritage of mental weakness was not unusual.

But the reform movement progressed; and in due course the sick in mind, who are often robust in body, were liberated from the local madhouses, and permitted to come out into the sunlight and carry on healthful activities. Men who had long been shackled are now at work in the fields. They have even assisted actively in the building of institutions in which such of them as are incurable will be housed and cared for according to humane and modern methods.

Dr. Thomas W. Salmon, director of special studies of the National Committee for Mental Hygiene, asserts that there are no fewer than fourteen States in which care of the insane in county almshouses is still permitted.

"Whereas the care of the insane in a few enlightened States is a matter of just pride," he says, "there is not a single condition which existed in the early period of neglect and abuse which does not exist to-day in some American communities."

I would suggest that each reader of these lines appoint himself a committee of one to ascertain whether the community in which he lives is of the eighteenth century or of the twentieth in its treatment of the insane.

If the victims of mental disease in your community still go uncared for in jails and poorhouses you can do no more humane and useful work than to promulgate a reform movement along the lines of those that have been carried out in the more civilized communities of our country.

First Aid to the Mentally Wavering

But, as already intimated, the problems of mental hygiene are only secondarily concerned with the insane.

The watchword here as elsewhere in the modern world is prevention.

The ideal is, not merely to provide proper treatment for the individual after mental breakdown, but to show the individual how to obviate breakdown. The world is full of persons of unstable mentality who would gladly consider advice as to the correction of their abnormal tendencies, did they but know where to seek it.

One very practical way of getting at these borderland cases is through the establishment of psychiatric clinics, such as that recently opened in Baltimore in connection with the Johns Hopkins Hospital. This clinic, with its fine building just under construction, was endowed by Mr. Henry Phipps, who was led to take an interest in the matter through the suggestions of Dr. William Welsh.

The idea was perhaps gained in part from the principal existing European clinics of like aim,

which had their original inception in the fertile mind of the Swiss alienist, Dr. Greisinger; the best-known existing institution being that in charge of Professor Kraepelin of Munich. But Professor Welsh is authority for the statement that Mr. Phipps was to some extent influenced by reading Mr. Beers' story of his institution experiences.

The Henry Phipps Clinic is in charge of Dr. Adolf Meyer. Its good work is already under way, and its foundation may well be regarded as marking a new era in the history of the treatment of mental disease—the era of prevention.

Other new institutions having the same aim are the Psychopathic Hospital at Ann Arbor, allied with the State University, the Boston Psychopathic Hospital, and the Psychiatric Clinic at Bellevue Hospital in New York.

Persons who feel that their mental efficiency is below par may here seek expert advice, and be put on the track of mental methods that make for normality and tend to ward off mental disease.

It is believed that in the immediate future psychiatric clinics on the lines of these new institutions will be found in connection with every important medical school and hospital and dispensary throughout the country, and that local societies, co-operating with the National Committee for Mental Hygiene, will be established in every community.

In three States, Connecticut, Illinois, and Massachusetts, such affiliating societies are already in

operation, and in New York the same work is being carried on by the Committee on Mental Hygiene of the State Charities Aid Association. These societies stand ready to give free verbal or written advice to all who desire information regarding the principles of mental hygiene, and the avoidable causes of mental disorder. In particular they extend a helping hand to individuals who fear nervous or mental collapse.

They do not usurp the functions of the physician, but they co-operate with him; often they induce the patient to seek medical advice when he would not otherwise do so.

If there is as yet neither psychiatric clinic nor local mental hygiene society in your community, you may apply, with full confidence, to the Secretary of the National Committee for Mental Hygiene, 50 Union Square, New York, for advice along the lines in question, or for helpful literature.

Of the far-reaching educational influence of these movements there can be no question. In the course of the coming decade or two we may hope to see the spread of popular information regarding mental hygiene duplicate in some measure the recent progress of knowledge of hygiene of the body. The general public has been given a clear notion regarding the proper physical care of infants and children, and it has been taught the vital need of physical exercise for persons of all ages. This lesson learned, it is time to turn attention to the brain.

Mental Hygiene

It is desirable to keep your muscular system in good order—strong and resilient. But this is not absolutely essential, except for the professional athlete.

Your muscles may be too weak to lift a trunk, but you can hire a porter to lift it.

But on the other hand, suppose your brain is not so developed as to work with maximum efficiency. What then? Your mind is below par in some or in all of its operations.

And now it is no longer a question of hiring someone to do the work that you cannot do. Weak brains do not hire assistance; they put their possessor in the class of the hired—and the wage is small.

The essential difference between the bank president and the man that tends his furnace is a difference of only a few ounces of brain substance. But these few ounces are of inestimable value.

Good brain substance is about the only thing in the world that is never a drug on the market.

When we think of the matter in this light, it seems rather strange, does it not, that there are hundreds of thousands of men giving heed to keeping their muscles developed—taking home exercise, going to gymnasiums, playing golf and tennis—where one individual gives definite thought to the specific development of brain power?

In so saying, I would not ignore the fact that

health of muscle is helpful to the brain. But physical health can do no more than prepare the soil, so to speak, for mental action. The free circulation of healthy blood gives the brain physical materials for action; but a man might be a champion athlete and yet be a child in knowledge. Mental hygiene includes physical training, but it goes beyond. After the brain is made physically healthy, it must be trained as the organ of observation, thinking, and acting.

As you test your muscles from time to time, you might well also apply some definite tests as to your memory, your capacity for concentrated thought, and your will power.

When men are sought to fill high positions, the questions asked do not concern the golf score or the size of biceps. They concern the capacities of brain and of mind. Darwin and Spencer were frail, sickly men. The work of their bodies would have gained them scant livelihood. Their brains transformed the entire intellectual viewpoint of Christendom.

Brain and Mind

Of course everyone vaguely knows that all mentality depends upon the action of the brain. Yet the fact is often slurred over or ignored. So it cannot be amiss to emphasize the relation in specific terms.

"Mind" and "brain" are not synonyms of course; but one depends absolutely upon the other.

No one competent to judge doubts that every

mental action has a physical substratum in the brain; and that every perverted mental action is evidence of a perversion, however intangible, of the brain substance. So the physical welfare of the brain is directly concerned in all questions of mental hygiene.

Moreover—and this is the most important fact of the entire subject—abnormalities of the brain, when fully developed, may be quite beyond repair although it might have been perfectly feasible to prevent their development. The essential structures of the organ of thought include myriads of specialized cells of exquisite delicacy. Under the microscope they appear like tiny arrowheads, sharply outlined, with infinitesimal fibrillar appendages that convey messages from one cell to another.

Each cell might be likened to a storage battery, and the connecting fibrils to the wires of an electric system.

The brain operates effectively only while both cells and connecting wires are in good order.

Ramifying everywhere among the cells are the all-essential blood vessels. In order that the brain cells should functionate at all, they must be supplied with oxygen-carrying blood. Any alteration in the blood supply makes a vital attack upon the brain. You may produce unconsciousness almost instantly by pressing on the arteries in the neck. Any vitiation of the blood-stream is felt by the sensitive cerebral tissues more quickly and more vitally than by any other tissues.

Hence it is that a drug like alcohol, which may disturb the normal condition of the circulation, makes its influence felt immediately, and persistently on the brain.

Not only does alcohol change the quantity of blood that circulates among the thought-producing cells, but it vitiates the quality of the blood and reduces the capacity of the brain cells to take up oxygen, upon the presence of which their power absolutely depends.

Stated otherwise, alcohol is a protoplasmic poison. Even in very small quantities it produces a measurable effect upon the activities of the sensitive brain tissues; an effect that may be tested in the laboratory and that has been demonstrated to continue for a term of hours even when a very small quantity of alcohol was taken, and for several days when a larger quantity is involved.

How Alcohol Mars the Brain

Not only so but the devitalizing effect produces changes in the protoplasm that are cumulative.

The brain cells subject to this abnormal strain gradually alter in their essential constituents and if the strain is long continued may become permanently damaged. If tangible demonstration of this were sought, it is furnished beyond all equivocation by the fact that alcohol is a recognized potent contributing factor in the causation of from one-fourth to one-third of all cases of insanity, the world over.

If this unequivocal fact could be made known to every young man who is gradually acquiring a taste for the regular use of alcoholic beverages, the effect on the mental efficiency of our race would be enormous. Dr. G. Sims Woodhead, of Cambridge University, England, describes the changes that accompany acute alcoholism, which include "marked degenerative changes in the inner lining of the small vessels of the brain, and an exaggerated condition of waste—a 'clogging' due to the accumulation of rapidly produced waste products in the lymph spaces in the outer walls of the vessels.

"It has been noted also," says Dr. Woodhead, "that in some cases small clots are found in the vessels—clots which interfere with the transmission of the blood along the normal channels. This clogging of the vessels and the spaces around them affords evidence that the tissues are breaking down very rapidly, but its chief importance appears to lie in the fact that it leads to continued interference with the nutrition of the surrounding tissues, thus playing a part in the determination of further degenerative changes."

These changes are of an alarming character. They include degeneration not only of the nerve cells themselves, which may become atrophied and fatty, but also in the fibrils that run out from the cells.

Even where the body of the cell remains intact, the fibrillar twigs may undergo remarkable changes.

"Little swellings make their appearance at regular intervals, first near the tip of a process, and gradually work their way back toward the body of the cell, so that after a time the process looks almost like a string of beads. Alongside these changes, some of the lateral twigs have become swollen and shortened, whilst others disappear; in advanced stages the bulk of them so disappearing."

This stunting and disappearance of the lateral twigs of the nerve fibrils, Dr. Woodhead tells us, is equivalent to severing the connecting wires of an electric system, and the communications between cell and cell are done away with.

Ultimately it may come to pass that "so many of the connecting wires are cut out, as it were, and the interference with the passage of nerve impulses along the nerves is so marked, that commencing with the more delicate processes of thought and going on to the machinery by which 'we live and have our being,' the nervous mechanism is gradually thrown out of gear."

These changes have been most fully studied in the brains of animals poisoned with alcohol, but Dr. Berkeley at Johns Hopkins Hospital has shown that they may also be demonstrated in the brain of a human being who has been an habitual drinker.

Such a draught on the brain structure, with the inevitable attendant loss of mental power, is a high price to pay for the transient pleasures of alcoholic indulgence.

Syphilis and Brain Decay

There are various toxins of bacterial origin that have an effect on the brain that is closely similar to the effect of alcohol. Of these by far the most important from the present standpoint is the poison generated by the *spirochete* of syphilis. This is, indeed, the most important direct agency in the causation of brain maladies, next to alcohol.

Not only may syphilis cause degeneration of the arteries of the brain and destructive tumors (called gummata) in that organ; but it also threatens its victim with the most pitiful and hopeless of all forms of insanity, general paralysis, or paresis, colloquially known as softening of the brain.

This terrifying disease, which hurries the patient to complete dementia and an early death, never comes to anyone who has not had syphilis; hence it may properly be spoken of as a terminal form of that malady.

General paralysis is a very common form of insanity. The paretics that come to the New York Hospitals for the Insane each year amount to 17 per cent of all men and 8 per cent of all women admitted. The pitiful and hopeless decay of mentality that these patients exhibit is matched by the destructive lesions of their brains, as may readily be demonstrated post mortem, both by macroscopic inspection and by study of the brain tissues under the microscope.

The brain will be seen to be actually shrunken in size, a layer of watery fluid taking the place of the withered brain tissues. The arteries are thickened and their walls altered in texture. The cells of the cortex—the all-essential gray matter—have undergone degenerative changes; many of them are altogether obliterated, and their place taken by tissues that are as useless for purposes of mental activity as so much putty.

The proportion of cases in which syphilis ultimately leads to this result is appallingly large.

A very careful analysis has recently been made of the cases of syphilis among officers of the Austrian army during a long term of years, the aggregate number being 41,000. Most of these cases were doubtless given the very best medical treatment, yet nevertheless 4.6 per cent of all syphilitics, or almost one in twenty, were finally stricken with paresis.

The proportion would probably be much larger could full statistics be gathered of persons in civic life, who on the average would be less effectively treated in the early stages of the disease than were the Austrian officers.

Syphilis itself is a disease of many painful manifestations in its earlier stages; the likelihood that it may lead to this termination in the most fatal and deplorable of mental maladies, should be an additional warning against the well-known lapses of moral conduct through which the disease is acquired.

" Over the door of every immoral resort," says

a leaflet recently issued with the authority of leading alienists, "might truthfully be written: 'Incurable insanity may be contracted here.' If self-respect, the desire for the good opinion of others, the influence of religious training, and the attractions of home life are not sufficient to prevent this kind of wrong doing; the danger of contracting a disease which may result in incurable insanity should be sufficient."

I wish I could bring that thought-provocative paragraph to the attention of every boy and young man, of every father of sons, and of every educator of youth in America. No comment could add to it. No amount of sermonizing could approach it in forceful suggestiveness.

V.

Are Your Nerves in Tune?

DO you ever suffer from "nerves"? Are you at times cross, fidgety, unstrung, irritable, apprehensive, despondent? Do you ever get in such a state that your friends say your nerves are on the outside? Then read this chapter and find out what to do about it.

You know that you have a nervous system; but did you know that you have two of them; and that one sometimes treats the other badly? Did you know that your secondary nervous system performs miracles every hour that no scientist could duplicate in his laboratory? There are more cells in your body than there are people in all the world, and every cell is an individual organism that must be fed and exercised and renovated by the removal of its waste products.

The secondary nervous system, of which you perhaps never heard, performs this work,—a far more wonderful task than anything you ever do consciously.

The wisest physician in the world could not care for one of these cells a single hour as your sympathetic nerve-ganglia care for the billions; the most skilful surgeon could not repair a pin-scratch without the aid of these nerves.

Yet this wonderful apparatus needs your assistance. How do you aid in the work it carries on in your behalf? It is more than likely that you do not do your part very well. Yet if you treat this other self of yours badly, you must pay the penalty—and the penalty is "nerves" of the kind you do not relish. These pages will show you your duty to yourself, and attempt to point the way to a healthier and happier way of living.

Like a Telephone System

There has recently been founded in New York City a new kind of clinic called the Neurological Institute. Several of the most prominent nerve specialists have combined forces to start this institution, which, as its name implies, will be devoted to the treatment of the various nervous diseases.

The establishment of such an institution is symbolic of the times. We are all familiar with the assertion that this is a nervous age, and a good many evidences are at hand that tend to prove the assertion. In the cities in particular, under the conditions of hurry and stress that there obtain, neurasthenia or nervous prostration has become more and more popular. But similar conditions are becoming increasingly familiar among the patients of the country doctor as well. And indeed this is inevitable, for nervous breakdown follows under strain almost as a matter of course, and everyone knows that the conditions of the

past few years have added to the average stress of living.

But just what do we mean when we speak of "nervous breakdown"? The words are on everyone's lips, but like a good many other familiar phrases this one is not always clearly understood by those who use it. To gain an inkling of what the words really imply we must briefly consider the normal functions of the nerves.

These functions, it appears, are exceedingly simple, notwithstanding the complex conditions that result from their derangement. It is scarcely an exaggeration to say that the sole function of the nerves is to convey impulses.

They are in effect telephone wires carrying messages from one part of the organism to another, and from the outside world to the central nervous mechanisms.

The resemblance between the nervous system and a telephone system is really striking; but the analogy is complete only when we consider the telephone services of those cities—London and Los Angeles, for instance—that have two rival telephone companies in the same territory. For the human body has its two sets of nerves permeating to every nook and cranny of the organism, each set largely independent of the other, and each sending its fibres (conducting wires) to an independent receiving station or central office.

One series of receiving stations consists of a chain of small ganglia, or networks of nerve centres, extending along the spinal column, within

the body cavity, supplemented by similar ganglionic stations, all relatively small and inconspicuous, in various other cavities of the body. This meshwork of ganglia, together with the nerve cords that connect with it and run in all directions to find their chief termini in the organs of the body and in the blood vessels and lymphatics, is called the sympathetic system.

In vast numbers of lower organisms, including all creatures below the vertebrates, this is the only nervous mechanism.

But in man and his allies of the great tribe of vertebrates, a second system of nerve centres has been evolved—a rival or supplementary telephone system—which is far more complex, and from the standpoint of the intellectual life vastly more important than the original one. The central stations of this system are known as the brain and spinal cord. To protect these masses of nerve cells, the skull and spinal column were evolved, and the entire structure of all higher animals was modified accordingly.

The nerves that go out from the brain and spinal cord connect at their free ends with muscle fibres, or they are spread out to form a meshwork in the skin, or they are modified to serve the purposes of the organs of special sense.

It is these nerves, conveying their message to the spinal cord and brain, that are involved wherever we are conscious of any contact with the other world, either through the tactile sense, or through the sense of taste, smell, hearing, or

sight. The impressions from the world as gained by the skin, or tongue, or eye, or ear, set up "nervous impulses" that are transmitted to the appropriate centres in the brain, and these centres interpret the impressions as states of consciousness which we speak of as sensations.

The Brain Mechanism

If you could look back into this great receiving station in your head with the eyes of the microscope, you would find that each nerve fibril that comes to it from the outlying regions of your body terminates finally in a minute ganglion cell. There are millions of these cells, arranged in rather definite layers scattered everywhere through the gray matter or cortex of the brain. Certain localized groups are given over to the reception of each kind of impression, and the nerve cells that control definite functions are similarly localized. But they are intermeshed and linked by connecting fibrils.

There are, for example, a few convolutions near the centre of the brain where the cells are located that directly control the activities of the voluntary muscles. Injury to this small area would cause paralysis of the groups of muscles on the opposite side of the body,—for a large number of nerve tracts cross over from the right side of the body to the left side of the brain and *vice versa*.

Again, there is a small area in the left frontal region, the brain cells of which control the memory

of words as used in ordinary speech. Injury to this region may cause so-called aphasia, with its characteristic symptom of incapacity to talk because the names of things cannot be recalled, even though the individual is perfectly conscious and retains all other evidences of intelligence.

As to the more abstract processes of mind, the localization of cells is less specifically known. In point of fact it seems probable that for the processes of intellection large numbers of the cells are involved, and that these cells are scattered in widely different regions of the brain, being linked with connecting nerve fibrils which run everywhere through the central substance of the brain, like telephone wires connecting the numberless telephones of a system.

The processes of memory, we may suppose, are associated with the reproduction of cellular activities of the brain which duplicate vibrations that came to them at an earlier period.

As for the messages that go out from the brain, along the nerves of the sensory-motor system, it is rather startling to discover that these consist solely of orders transmitted along the motor nerves to the fibres of muscles, directing these fibres to contract. Intricate and elaborate as are the brain processes, with their conscious equivalents, the sole method by which the brain is able to control the body it dominates is by thus directing the activities of the muscles.

It is necessary to have an exceedingly intricate system of nerves devoted to this purpose because

it is absolutely essential that the several hundred mucles of the body should operate in harmony.

What results when there is any disarrangement of this harmonizing central mechanism is well illustrated in the convulsive seizures of a victim of the familiar disease called epilepsy. In the epileptic seizure each muscle of the individual is acting normally, but through lack of cerebral control the muscles are all put into action simultaneously, one set opposing another in a hopelessly inco-ordinate struggle that amounts to a civil war among the members of the bodily organism.

Under normal conditions, on the other hand, the messages sent out from the central mechanism are so skilfully regulated that harmonious groups of muscles are put into action together and opposing muscles rendered quiescent.

You could never so much as bend your elbow if the triceps muscles at the back of your arm did not relax while the biceps muscles are contracting.

In producing this harmonious action of the muscles, the function of the nerves proper, as we have seen, is merely to transmit impulses from the central generating station. Yet the absolute importance of the transmitting nerves is easily demonstrated; for if one of these nerve tracts is severed—say, by a knife wound—the muscles supplied by that nerve becoming instantly "paralyzed"; they remain totally quiescent notwithstanding any commands that the brain cells may attempt to give them.

Here again the likeness to the telephone system is obvious: the wires must be intact or no messages can be transmitted.

The Action of the Sympathetic System

The activities of the brain are primarily associated with the familiar phenomena of consciousness.

Under normal conditions, we can consciously control the messages that result in action of the bodily muscles. We can move our arms or feet or actuate the muscles of the vocal apparatus at will. It is true that many movements that are habitually repeated come to take place, as it were, automatically and without conscious direction. The movements involved in walking furnish a familiar illustration. The action of the chest in breathing is an even more striking instance. But it is possible to bring these movements within the scope of consciousness, and to direct them at will by fixing attention upon them.

There are other sets of bodily activities, however, that are not subject to such voluntary control.

Such, for example, are the activities of the entire apparatus of digestion and assimilation, the all-important and unceasing action of the heart, and the contraction and relaxation of the muscular coats of the arteries and arterioles by which the distribution of the blood in the body is largely controlled.

The function of breathing also falls, in the last analysis, among those essential life processes that are not dominated by the conscious mind; whereas we can regulate the breathing muscles within certain bounds, we cannot prevent their operation altogether. However hard you try to hold your breath, the "automatic" control of the breathing apparatus will presently overmaster the conscious effort at retardation.

In a word, then, it is obvious that the so-called "vital" functions, those that must be perpetuated in operation in order to maintain life, are placed beyond control of the conscious mind. They are, in point of fact, controlled by the sympathetic system of ganglia scattered throughout the body cavities. The relatively inconspicuous ganglia that control this system have the needs of the organism constantly under surveillance.

It appears, then, that the two telephone systems of the body are not rival systems; they are complementary.

If the bodily mechanism tends to run short of fuel, the sympathetic ganglia telegraph a message to the conscious brain centres which is interpreted as a sensation of hunger. The muscles under conscious control then secure food and convey it to the stomach.

But here the sympathetic ganglia resume control. They send messages which cause relaxation of the walls of the blood vessels supplying the stomach and other digestive organs, so that an increased flow of blood to these parts takes place.

Thus stimulated the various glands of the stomach and intestines and liver and pancreas secrete the digestive fluids that transform the food into absorbable compounds. If meat has been eaten largely, the supply of gastric juice must be plentiful; for fatty and starchy foods, pancreatic and hepatic juices must be supplied in just the right quantity.

All this is controlled by the sympathetic ganglia. So are the further steps through which this assimilable material is taken up by the lacteals and ultimately distributed to the uttermost parts of the body, there to be used in rebuilding broken down tissues or as fuel for the bodily machine in general.

And under normal conditions, these varied activities are performed so independently of the brain centres as to leave no record in consciousness.

These miraculous transformations are going on in your body,—such transformations as no chemist could duplicate, in the laboratory,—and you are utterly unconscious of the entire procedure. Your brain is busy with other duties, or is sleeping—it matters not: the perpetual vigilance of the sympathetic system keeps the commonwealth of cells and tissues of many types in healthful activity.

There is, nevertheless, the closest harmony of action between the two nerve systems, notwithstanding the different systems of organs which *they* control.

Take a simple illustration. Your brain mechanism, under certain stimuli, determines that your body shall enter into vigorous action. You decide, let us say, to participate in a running match. Your muscles, as directed by your brain through impulses sent along motor nerves, are caused to contract with great vigor, and as such contraction is associated with a large consumption of fuel and the liberation into your veins of excessive quantities of waste products, it becomes instantly necessary to safeguard the bodily mechanism as a whole. There must be an accelerated flow of blood, the lungs must functionate more quickly to supply oxygen and remove carbonic acid gas; and the blood vessels at the surface must be opened to full capacity, and the perspiratory glands put into full action to facilitate the elimination of heat lest the bodily temperature be raised to a dangerous level.

And the unconsciously operated sympathetic mechanism proves equal to these needs. Your heart beats with redoubled speed and force. Your breathing becomes rapid and deep, your skin is flushed, and perspiration breaks out all over your body.

You have had no conscious thought of anything beyond the muscular exertion involved in running; but the sympathetic mechanism has operated in harmonious coalition with the spinal cord and brain, with the result that a whole coterie of essential functions lying beyond the control of the conscious mind, many of them utterly beyond

the pale of consciousness itself, has become operative.

It is a marvelous coalition, this federation of the two great seemingly independent nervous systems. Neither system could do the work of the other; each must find support in the other; working together they control the most wonderful of all mechanisms, the bodily machine; working in harmony they ensure that mechanism life and health and strength within its hereditary limitations; but if either fails or if either shirks its share of duties, disaster results and the organism falls prey to disease.

Imposing on Your Other Self

To get a clear idea of the situation, we must recall that there are in your body more cells than there are people in all the world, and that every cell is an individual organism that must be fed and exercised, and renovated by removal of its waste products.

The sympathetic nervous system controls this vast population, and attends to its needs. Every individual cell, located in any out of the way part of your body must have its appropriate modicum of food brought to it through blood vessels and lacteals, and the waste products of its activity must be promptly removed; otherwise your organism would very soon suffer complete demoralization and all activity would be at an end,—that *is to* say, you would die.

The function of the sympathetic nervous system might then be likened to that of the commissary department of an army.

The supplying of food, and the general routine of hygiene, as applied to the army, is a service that gives little glory in comparison with the marshaling of the troops in battle array, and the strategy that makes for the winning of battles; but it is an absolutely essential service none the less.

And so the unconsciously operated activities of the sympathetic nervous system, which are responsible for the bodily functions, are absolutely essential to your well-being, however your conscious mind may be disposed to regard these mere "animal" activities.

But what shall we say of the manner in which you, as a conscious personality, carry on your part of the work necessary to the harmonious operation of the two nervous systems? The sympathetic system, as we have seen, is absolutely dependent on the brain system for the supply of materials with which it operates. How does your brain—the arbiter of your conscious ego—perform its share of the divided labors?

If you consider the matter attentively, you will probably be disposed to admit that the answer is not greatly to your credit.

More than likely you supply the digestive apparatus, which is the laboratory wherein the sympathetic nervous system directs the preparation of materials for feeding its vast army of cells, with food that is often of doubtful quality, or

[illegible]—what [illegible] excessive quantity. [illegible] how to make [illegible]ursement.

[illegible] excessive supply [illegible] an excessive [illegible]

[illegible] mother [illegible] is [illegible] promptly [illegible]

[illegible] stress [illegible] there are [illegible] right [illegible] as

is more than likely, you give them an inadequate supply of oxygen, because you prefer to live and sleep in ill-ventilated rooms.

Perhaps you further complicate their problem by introducing out and out poisons, such as alcohol and nicotine and caffeine, which tend to paralyze the activities of the digestive laboratory and interfere with the normal preparation of pabulum for the cells.

It is even probable that you are neglectful about so fundamental a matter as the supply of adequate quantities of that great universal diluent and solvent, water, without which the most skilful laboratory workers of the digestive system cannot properly perform their labors.

Against these impositions the sympathetic nervous system usually makes no protest. It labors incessantly day and night to make the best of the hard task you set it—to correct, as far as may be, the mistakes that you, the consciously directive and supposedly intelligent member of the coalition, are constantly making. If too greatly imposed upon, however, the ganglia of the sympathetic system at last make protest that is heard at the headquarters in the brain—registered usually in the form of disagreeable or painful sensations which you interpret as indigestion, mal-nutrition, or aches variously located or as a general condition of depression.

Then the response you make is, not to correct the errors of your diet and hygiene, but to go to a physician and ask for some magic drug that

will set right the complex machinery at a dose, to make amends for all your hygienic sins of commission and omission.

The doctor cannot supply such a remedy of course; he would have greater skill than the chemists of the sympathetic nervous system itself if he could. But he will give you something to palliate your symptoms, accompanied with good admonitions that you will for the most part fail to heed; and, after a momentary period of relief you will go on imposing upon the patient and long-suffering sympathetic nervous system that constitutes your other self in the same reckless manner as before.

Not a commendable way, surely, for a commander-in-chief to treat a loyal, efficient, and ever vigilant lieutenant of the all-important commissary department: that you will admit.

Imposing on Brain and Spinal Cord

Of course your derelictions of diet and general hygiene, which thus put impossible tasks upon the sympathetic nervous system, and which inevitably accomplish the derangement of function of various and sundry of your bodily tissues, will make its influence felt on that other nervous system which has for its most conspicuous organs the spinal cord and brain. For these important structures are not only directly linked with all the tissues of the body by nerve cords, but their cells are themselves physical structures which depend

no less than muscle cells or gland cells on the good offices of the sympathetic system for their food supplies and for the removal of the waste products of their activity.

So your ill-treatment of the sympathetic system reacts upon the brain and results directly in the lowering of its power of energizing upon which all your mental functionings depend. Now things are working in a vicious circle.

But in addition to this, it is more than likely that you put a further handicap upon your brain and the nervous apparatus with which it is directly connected by the tasks to which you subject it.

For example, it is probable that your habits of mental work are not of the best. It is likely that you have never learned the value of regular sequence of work time and rest time for your brain which proper habits of sleeping would give.

It is likely that you subject your brain to periods of undue stress through overwork; that you subject it to the wearing influence of worry or of fits of temper.

It is probable that you take into your system more or less regularly drugs that directly interfere with the normal functioning of the brain cells, of which drugs alcohol, nicotine, and caffeine are the most familiar examples.

All these things constitute impositions on the brain cells whose proper functioning is absolutely essential to your normal mental activity. And the inevitable result of such imposition is that the brain cells perform their functions less effi-

ciently than they otherwise would do. It is demonstrable under the microscope that brain cells that have been overworked suffer an actual breakdown of their substance so that they become vacuolated, as the technical phrase is; that is to say, portions of the active cell substance are substituted by droplets of serum that have no more power of nervous functioning than so much water.

If the strain is not too long continued, the brain cells may be repaired and restored to their normal condition; but if the imposition is carried too far there results actual and permanent degeneration of the brain cells themselves.

Such a condition of the brain cells is noted, for example, in those extreme cases in which the brain has been subject to the toxic influence of alcohol habitually for prolonged periods. The brain of the dipsomaniac becomes shrunken through decay of its essential cells, and a layer of watery fluid between the brain surface and its surrounding membranes takes the place of the essential nerve tissues.

This is further accentuated if the virus of syphilis has been added to the toxic influences operating against the brain cells. In that case the decay of cells may become so noticeable as to lead to almost complete abolition of mentality. Frequently the walls of the arteries supplying the brain become weakened through degeneration of their cells, and hemorrhage into the brain substance causes permanent paralysis or ends the life of the patient outright.

Short of these extreme cases, however, the brain that is subject to the disturbing influence of malnutrition and overwork and worry and uncontrolled bursts of emotion carries a perpetual handicap in attempting to perform its function of co-ordinating the messages that come to it and regulating the responsive muscular activities. It is the brain thus harassed that becomes abnormally susceptible to impulses from the outer world and erratic and inco-ordinate in its responses to impulses in general.

The person whose brain cells are thus maladjusted becomes unduly sensitive to noises or disturbances of any sort.

He is irritable and emotional; he cannot adjust himself to the minor annoyances that are inevitable in business and social life. He becomes painfully conscious of the perverted functioning of his visceral system.

He is afflicted with exaggerated sensations which may take the form of acute pains or of a pervasive sense of ill-being, apprehension, and hypochondria.

Worst of all, his harassed brain cells reach a stage of sensitiveness in which they are perpetually responsive to the messages sent to them from various parts of the body. This means that he cannot sleep: and prolonged wakefulness in itself produces further exhaustion of the brain cells, as the experiments of Dr. George W. Crile, the famous Cleveland surgeon, have recently shown.

When your nervous mechanism has reached such a stage of derangement as this, you are said to be suffering from neurasthenia or nervous prostration. Your less charitable friends are apt to say of you that your nerves are on the outside of your skin. But what is really at fault, as we have seen, is not so much the nerves themselves, which after all only convey the impulses that come to them, as the essential cells of the spinal cord and brain where these impulses are normally gathered and controlled or co-ordinated.

Your telephone wires may be all right. It is the receiving and transmitting apparatus that is at fault.

Remedies Versus Prevention

The specialist to whom you apply prescribes just what you might expect, now that you know what caused your condition of "nerves."

He puts you on a rational diet, and tells you to drink plenty of water and little of anything else unless it be milk; to live in the open and inhale any amount of oxygen; to stop work and worry, and if possible to get into the country where things are quiet and your tired brain cells can have a rest. Perhaps he treats you with a high frequency electric current, to soothe your muscles and arteries; he may use the resources of hydrotherapy to stimulate your enervated and rebellious tissues; he counsels rest in bed or exercise in the open, according to your precise stage of cellular demoralization. Or he may combine most

of these prescriptions in one by ordering you to the Hot Springs.

This is all very well; but would it not have been a good deal better, from your standpoint, to have avoided the need of these prescriptions? Is not this pre-eminently a case where prevention is better than cure? Obviously; but how prevent a disaster of such insidiousness of approach and of such varied factors of causation?

To be sure you might have rationalized your diet and your habits of exercise, and that would have done much for you.

But what about the derangements due more specifically to perverted activities of the brain?

It is easy enough to counsel moderation and the avoidance of overwork and worry, and the like; but it is obvious that advice as to these things may partake more or less of the admonition to lift one's self up by one's boot straps.

The average man does not overwork of mere choice; he does not worry because he prefers to do so; he does not even give way to bursts of temper without effort to control his emotions. If he subjects his brain to these disturbing influences, he does so because he knows not how to avoid such disturbances. The conditions of his environment are really responsible for his cerebral maladjustment. His brain cells give incoordinate responses and suffer undue fatigue because impulses that come to them from the outer world are excessive, or maladjusted to their capacity.

Square Pegs and Round Holes

And it is precisely here that the modern psychologist steps into the field and offers a solution of the problem of adjustment of the average brain to the average environment. The difficulty, says the psychologist, which primarily leads to the observed condition of undue nervousness and an unwarranted number of nervous breakdowns, is that a very large number of brains, under the existing condition, are so trained that they do not have a fair chance to functionate normally.

One reason is that the young men and women of our time very generally select their vocations haphazard and without reference to their fitness or unfitness for the tasks. Thus there are numbers of misfits,—square pegs in round holes, as the saying is.

As a consequence, work is performed badly and inefficiently, while the workers themselves suffer undue strain attempting to keep pace with other workers who are inherently better adapted for that particular task.

Take by way of illustration a specific case cited by one of the prominent modern students of efficiency in business, Mr. Harrington Emerson. "The type for the great newspaper," he says, "is set up by linotype operators. Apprenticeship is rigorously limited. Some operators can never get beyond the 2500-em class, others with no more personal effort can set 5000 ems. Do the employers test out applicants for the appren-

ticeship so as to be sure to secure boys who will develop into the 5000-em class? They do not; they select applicants for any near reason except the fundamental important one of innate fitness."

It is obvious that under these conditions a good share of the workers will be in the 2500-em class, and that these all their life will be subject to undue strain in attempting to compete with their 5000-em co-workers.

And this specific case is typical of what applies in a thousand other lines of work, both mechanical and mental.

Mr. Emerson believes that the difficulty might be met by providing that young men and women to enter any given trade or profession should be selected by competent specialists who have "supplemented natural gifts and good judgment by analysis and synthesis that enable them to perceive aptitudes and proclivities even in the very young, much more readily in those semi-matured, and can with almost infallible certainty point out, not only what work can be undertaken with fair hope of success, but also what slight modification or addition and diminution will more than double the personal power."

The Psychologist to the Rescue

But Professor Hugo Münsterberg, the Harvard psychologist, very much doubts the availability of any such intuitional power as this. He would pin his faith rather to the methods of laboratory, and

would attempt to substitute the results of scientific investigation for what he terms mere guesswork. In illustrating what may be done in this direction, Professor Münsterberg cites various interesting cases.

He tells, for example, how Mr. S. A. Thompson applied the method of the psychological laboratory to testing the workers in a bicycle factory where 120 girls were inspecting the balls. The results of this test were so remarkable that they may well be given in detail. The case is peculiarly interesting because the work involved was of so simple a character that it might almost be thought that one person of average intelligence could do it as well as another.

The task was this: The girls had to place a row of small polished steel balls on the back of the left hand, and while they were rolled over and over in the crease between two of the fingers placed together, they were minutely examined in a strong light, and the defective balls were picked out by the aid of a magnet held in the right hand.

A simple enough task, even though requiring close attention and concentration. But now note what Professor Münsterberg says:

"The girls were working ten and a half hours a day. Mr. Thompson soon recognized that the quality most needed, beside endurance and industry, was a quick power of perception accompanied by quick responsive action. He knew that the psychological laboratory has developed methods for a very exact measurement of the time needed

to react on an impression with the quickest possible movement; it is called the reaction-time, and is usually measured in thousandths of a second. He, therefore, considered it advisable to measure the reaction-time of the girls, and to eliminate from service all those who showed a relatively long time between the stimulus and reaction."

The test resulted, we are told, in showing that many of the most intelligent, hardest-working, and most trustworthy girls were not naturally fitted for the task.

When these misfits were eliminated, it was found possible to shorten the hours and reduce more and more the number of workers, with the final outcome that *thirty-five girls did the work formerly done by a hundred and twenty,* and that the accuracy of the work at the higher speed was two-thirds greater than at the former very slow pace.

" This allowed almost a doubling of the wages of the girls in spite of their shorter working-day, and at the same time a considerable reduction in the cost of the work for the factory."

From Laboratory to Work Shop

Such a result is surely stimulative. And there is no reason to suppose this an exceptional case. But the work is only begun.

Professor Münsterberg, however, has been led to take the matter up in his laboratories, in the endeavor to develop tests that might be of practi-

cal value in selecting applicants for various lines of work.

It should be explained that the delicate apparatus of the psychological laboratory enables the experimenter to test such important matters as the reaction-time of any given brain to a given stimulus, the time required by the brain cells of a given individual to make a selective judgment, and the like; and that different brains differ very materially as to these important and fundamental reactions. It is obvious that there are many lines of work in which quick reaction-time is one of the most important elements for the development of efficiency, just as in the case just cited.

But it is seldom possible without careful analysis to determine just what the elements are in any given case. In Professor Münsterberg's words, "The subtler *nuances* of difference between tasks can be gained only by an intimate knowledge of the industry." And he gives this very striking illustration:

"In the case of a well-known type-setting machine, thousands of which are in daily use, I had the impression that the rapidity of the performance was dependent upon the quickness of the finger reaction. The managers, on the other hand, have found that the most essential condition for speed in the whole work is the ability to retain a large number of words in memory before they are set. The man who presses the keys rather slowly advances more rapidly than another who moves his fingers quickly, but must make

many pauses in order to find his place in the manuscript and to provide himself with new words."

Commenting on this case, Professor Münsterberg analyzes the factors that must be brought into correlation if we are to enable the individual to make a wise selection of a vocation. We must consider, he says, " first the actual experiences of managers; secondly, the observations of skilled psychologists in the industrial concerns; thirdly, psychological and experimental investigations with successful and unsuccessful laborers; and, fourthly, experimental studies of the normal variability."

He points out that if such a programme is to be realized in detail, it will be necessary to discriminate between inherited traits and those that are acquired.

Each individual must be studied as to his " capacities of attention and emotion, memory and will energy, disposition to fatigue and to restoration, imagination, suggestibility and initiative, and many other features."

Practical Tests that You Can Apply

A good deal of this will be doubtless carried out in the schools of the not distant future. In the meantime, you may personally apply practical tests to yourself and your children that will be of the utmost value, even though you have scant knowledge of psychology.

You can, for example, see that your children's

eyes, ears, noses, throats, and teeth are cared for. Defects of any of these organs may be sources of constant irritation to the brain. Eye strain, due to some easily remedied error of refraction, may cause more fatigue of the brain than all the studies of the curriculum. Dr. S. Josephine Barker, Director of Child Hygiene in the New York schools, states that among the school children of the metropolis "there are 60,000 cases of defective and untreated eyesight, 65,000 cases of defective nasal breathing, 82,000 enlarged tonsils, and 400,000 young mouths that harbor diseased teeth." It would be hard to estimate the amount of brain wear, exhaustion, and actual perversion inadvertently resulting.

You owe it to your children to see that they are not similarly neglected.

Give careful heed also to the inherent traits and capacities of your children as revealed in their every-day conduct. Teach them nervous control—control over their emotions, their passions, their egoistic desires. This will be far more important than anything they will learn at school. And in aiding them to select vocations, when the time comes for that, consider their traits of mentality, their innate capacities, rather than your own predilections, and be governed accordingly.

Remember that the square peg in the round hole is at best a slipshod contrivance. "Better a good artisan than a poor artist" is a very wholesome motto.

As to yourself, you should be able to make an

analysis of your own mentality, based on comparison with the persons with whom you come in contact, that will be of inestimable value to you. Test yourself by wholesome introspection—never, however, carried to the stage of morbid brooding—day by day, and determine to better your quality of brain action, however good it was in the beginning. Remember that the all-important thing is brain control—capacity to restrain irrational responses, to turn the mind into normal channels, to bar out excessive action along one line, which constitutes worriment; to rest the mind by diverting it into new channels; to gain new and better habits of seeing, feeling, thinking, and acting.

Your Brain as a Phonograph

We have likened the brain system to a telephone system. From another viewpoint it is even more closely comparable to a phonograph.

But the brain is a far more sensitive and universal recorder of impressions than the phonograph, because the latter takes note only of the sound waves, whereas the brain makes permanent record of every sensation that comes to it,—not alone of sound waves, but of the impressions that are registered as sensations of touch, of taste, of smell, and of sight.

Each individual cell is a tiny storage battery that accumulates energy, and the cells are grouped together by connecting fibrils.

From earliest infancy, vibrations of various

kinds are being sent into the brain centres along the various nerve paths, and channels of action are being worn smooth as it were, so that particular types of action in response to these specific impulses become more and more easy and "natural." This is what we really mean when we say that certain habits of thinking and acting are being established.

It is all-important for the individual that the channels of nervous action thus early established should be those that result in right rather than in wrong action.

Heredity will determine something as to this. We all know, for example, that habits that are easy to acquire for one individual are hard for another,—for example, playing on the piano, or reciting poetry, or learning mathematics. But environment and practice will also determine much. We do not inherit knowledge; we inherit capacity to learn. The brain at birth is a blank record; a more or less sensitive one according to its inherited possibilities, but still a blank with all its possibilities unrealized, and unrealizable except through the right kind of experiences in after life.

Consider the treatment you give your mental phonograph as regards the matter that comes to it from the printed page along the channels of vision; and ask yourself whether you give your brain a chance to become properly educated.

You read newspapers doubtless. That is important; but are newspapers all-sufficient?

You read novels, and, according to Emerson,

novels may be as useful as Bibles, if they teach the right lesson. But do they by themselves supply an all-sufficient mental pabulum?

If you know by heart all the best fiction in the world, and nothing else, would you be really educated in a proper sense—fully equipped for your life work?

Obviously not. So you need to supply your mind with the records of serious books in which the mature thought of wise men of earlier generations has been recorded and accumulated. You need to supply your brain with matter worth remembering as material for building an effective mental structure. It was never more true than to-day that knowledge is power. And never before was so much *new knowledge* being presented for our edification each day; for this is the period of greatest scientific activity that the world has ever known.

Bear in mind, then, that every hour you give to desultory thought and vapid conversation, or to trivial reading is an hour not merely wasted but devoted to the permanent damage of your brain; because you are preserving what may be likened to a jangling, discordant noise record, graven on a phonograph cylinder that might have received instead a record of fine music.

And you have no excuse. For in these days good books are cheap and good magazines still cheaper. There are free lecture courses and free libraries everywhere. So regardless of your circumstances it is matter of choice with you whether

you will fill your brain cells with records of useful knowledge or make it a lumber room for an accumulation of trash; or, to hold to our figure, whether you will store your mental phonograph with the vibrations, let us say, of splendid operas and symphonies, or with rag-time; with Caruso records or with ribald songs of the underworld.

The Brain Records Are Permanent

It is obvious that after middle life most of us have very few experiences that could be called altogether new.

In the main our life routine is but a matter of perpetual repetition of old experiences. Our brains become grooved and channeled with oft-repeated messages which finally come to be transmitted so automatically that they tend to slip into the domain of the unconscious and subconscious. We perform a hundred and one tasks practically without giving them a thought, though they were difficult and even painful when they were first performed.

Our ideas and ideals become fixed and established nearly or quite beyond alteration. We have settled likes and dislikes; our vocabularies become limited to certain sets of words; and our phraseology takes on unvarying and readily recognizable forms.

In a way, most of us by middle life have become fossilized automata.

It is familiar experience that vastly the larger

number of impressions that come to us lapse presently into the realm of the unconscious. But, though unremembered, they nevertheless are permanently recorded in the brain. Dr. Frederick Peterson, of New York, has published an interesting account of tests made by him in association with Dr. Yung at Zurich, Switzerland, in which methods were found of getting at the unconscious and subconscious mentality by merely pronouncing various words and asking the patient to pronounce in turn the first words that come into his mind in response.

By such a test it is possible to show strange linkage of ideas which the psychologist can interpret in the light of the patient's early experiences, proving that the brain cells permanently retain records of events, even of the most trivial character, of which the conscious individual has no definite recollection.

Of similar import is the work of the Viennese physician Freud, whose theories of the interpretation of dreams have gained such wide vogue in recent years. He shows how full of meaning are the records that come into the foreground in the dream. Daytime experiences to which you gave no thought may be so deep-graven in the brain as to make the substance of haunting dreams, linked with experiences of childhood that had been no part of conscious mentality for perhaps a score of years.

Such interpretation of dreams as the Freudians make goes far to prove that each and every experi-

ence of our lives—each sensation, each thought, each correlation of ideas; every hope, desire, expectation, or emotion—leaves a permanent record in the mystic galaxies of brain cells.

Bear all this in mind as you are choosing your reading, your associates, your topics of thought and conversation. Remember that your mind at maturity will be largely what you have chosen to make it. "As a man thinketh, so is he," is the most literally true of maxims.

And remember, too, how imperishable is the record. Hour by hour of your life you are carving these tell-tale lines in your brain; and you can no more transform them all of a sudden than you can change your phonograph record from ragtime to symphony by merely wishing it changed.

Building a New Personality

But can the brain records be changed at all? This is the most important of questions; back of it lies the whole problem of education.

In point of fact, it is possible that no individual record can be changed except to make it more intense, or to allow it to become enfeebled through lack of repetition. But as all important experiences are complex, it is possible to pile up new records in the brain of such character as will tend to subordinate unfortunate earlier records, and finally to make them relatively inconsequential.

So there is always the cheering possibility of bringing new sets of cells into action,—of making

good records to supplement and subordinate the bad ones, and thus in effect changing the character of the brain action and of the personality associated with it.

In reality, each of us is thus building a new personality on the foundation of the old one, day by day.

Remember always this underlying principle: doing a thing once—good thing or bad thing—makes it easier to do that thing again. This is the basal principle of nervous action. Start a grooved channel of nervous impulses, and the tendency is to repeat. It is easier for future impulses to travel the old track than to break into new channels.

In reality the chief function of volition is to inhibit the responsive action of the brain cells which would tend to result in sending nervous impulses along old channels; and through such inhibition to make possible the opening up of new channels.

Remember that " will power " is largely power to prevent action. A trained will is one that holds the brain cells in leash, as it were, and determines that the nervous impulses sent out shall not always take the old familiar line of least resistance. All mental discipline may be summed up in the development of this inhibitory power of the will; for in the last analysis this is what we mean by mental training.

But all that has been said emphasizes the lesson that the right kind of training of the brain cells cannot be begun too early. The fewer bad habits

of nervous action, the less need there will be for unlearning and the easier will be the task of discipline. But however well the task may have been begun, the habit of training the brain cells to better and better lines of action is one that should be continued throughout life.

The test of conscious life itself is to be able to send out nerve stimuli from the brain. The test of youth—regardless of years—is to be able to set up *new* channels of innervation so grooved that they act automatically in the best way. And nothing else in life is so much worth while as to have a brain trained to act with the fullest measure of efficiency—to the full limit of its best capacities.

A brain thus trained will know how to select the right vocation, and how rationally to conserve its energies. There is little danger that nerves controlled by such a brain will ever get the better of you and "grow on the outside." They will always keep their place, and keep "in tune."

VI

Can You See Straight?

DO you see things as they are? Do things look to you as they look to others? Do you know that thousands of people have abnormal vision, and yet are not aware that they cannot see as others see? Eye-strain may cause headache, mental exhaustion, neuralgia, St. Vitus' dance, and even epilepsy.

Thousands of people suffer from one or another of these maladies, due to eye-strain, and do not know the cause. Do you know whether you are subject to brain fag in this way?

In particular do you know whether your children have eye defects that are making their studies difficult and threatening them with permanent injury? There are hundreds of thousands of children thus affected. You should *know*—not guess—whether or not yours are among them.

Again, even if your eyes and the eyes of your children are normal, do you know how to keep them normal? If not, you should find out. Eyes are too valuable an asset to be neglected. This chapter will tell you how to care for them.

Eye Surgery

Not long ago I spent an afternoon in the operating room of the New York Eye and Ear In-

firmary. There I saw Dr. John M. Wheeler perform a series of delicate and interesting operations.

In one case the eyeball was cut open and a piece of iris snipped out; in another the lens of the eye itself was extracted. An eyeball was cut out entirely and its place supplied with a bit of fatty tissue cut from the patient's leg,—not to restore vision, of course, but to prevent the socket of the eye from sinking.

In another case an eye that had too much internal pressure was drilled into with a tiny trephine. From yet another eye a chip of steel from a chisel was extracted with a gigantic magnet.

In yet other cases the muscles of the eye were cut to cure a squint.

And, most curious of all, perhaps, an eye that was opaque at the "sight" was tattooed with India ink and made much worse for the moment in order that later it might be restored to vision.

It was all very interesting. But what sank deepest in my mind was a chance remark of one of the physicians who watched the operations, as we came away from the clinic. "It is a wonderful thing," he said, "to be able to restore vision as the modern ophthalmic surgeon does; but most of these operations would have been uncalled for if the patients had taken better care of their eyes, particularly in childhood. A good share of the conditions that make the operations necessary are due directly or indirectly to slight errors of re-

fraction that could easily have been remedied at first with glasses."

"Errors of refraction." That is the phrase that is always on the lips of the eye specialist. Being interpreted, it means merely "eyes out of focus." We all know what that means nowadays, because we all take pictures with the camera and so are familiar with the blurred image of an out-of-focus picture. And the eye is just a living camera; the pictures on its sensitized film (the retina) may be sharply defined or they may be blurred. And you do not like a blurred picture any better in the eye than you like it on the photographic plate; so the eye that receives this blurred image strives constantly to get it in focus. If it has difficulty in doing so, there is what the specialist calls "an error of refraction."

Suppose, for example, that the globes of your eyes are a trifle shorter than they should be. Then the lens of your eye, which bends the rays of light and brings them together precisely as does the lens of a camera, will have a focal point lying a little behind the retina, and you will always be striving, consciously or unconsciously, to adjust the focusing apparatus. This will mean a constant and abnormal straining of the muscles of the eye. If the shape of your eyeball is but slightly abnormal, the focusing apparatus may overcome the defect, and you may have sharp vision. But the correction is made at the expense of an unusual and fatiguing effort.

It is a very wonderful mechanism, this focusing

apparatus in your eye; a very puzzling mechanism when we reflect that the normal eye is a camera of universal focus. With the photographic camera, you change the focus by lengthening or contracting the bellows, thus carrying the lens farther from the sensitized plate or bringing it nearer accordingly as you wish to photograph nearby or distant objects. But with the human eye no such change is possible. The lens lies back of the diaphragm (called the iris) precisely as in the photographic camera, but its position is fixed; it cannot be brought nearer the retina.

Yet the eye is at once telescope and microscope, focusing far objects and near in seeming defiance of the laws of optics.

This effect is accomplished by one of the most ingenious mechanisms that nature ever devised.

The Crystalline Lens

The gist of the matter is this: the lens of the eye, although called "crystalline," is not a rigid body, like the lens of a telescope or microscope; it is more like a bit of very firm gelatine.

It is held in position by an elastic capsule attached at the sides of the eyeball. Similarly attached to the circumference of the eyeball, just back of the iris, is a circle of muscular tissue. When this muscle contracts, it tends to constrict the iris and it relaxes the capsule that encloses the crystalline lens. The resilient lens, in virtue of its elasticity, assumes a thicker form, and a more

convex anterior surface. And this is precisely the change that is necessary to refract the rays of light coming from a nearby object and bring them to a focus on the retina.

When your attention is directed to such a nearby object, the series of changes just outlined takes place within the eye, and the result is equivalent to an extension of the bellows of the camera.

Contrariwise, when the eye is directed to a distant object, the ciliary muscle relaxes, the iris expands, and the capsule of the crystalline lens, freed from muscular tension, exerts its constrictive force on the lens, flattening that essential structure. This changes the refractive power of the lens in precisely the way necessary for focalization of light coming in almost parallel beams from the distant object.

Primitive Eyes

It is obvious that until some such mechanism as that just described was evolved, light could not be brought to a focus, and the organism would be aware only in a vague and general way of the nature of the objects from which the light came. Without this perfected eye, creatures could develop a considerable degree of intelligence, as such insects as the bee and ant amply prove. Yet, we may well doubt whether without a universal-focus eye any being could ever have come above the plane of intelligence of, let us say, the fish.

Only a creature having vivid impressions of its

surroundings far and near, such as vision alone can give, could get clear notions of the world in which we live; and such sensations are the building-stones of the mind.

The bee and the ant see only a little way; they depend on scent for their knowledge of distant objects, unless, indeed, they perceive vibrations of which we know nothing; and the range of impressions supplied by odors is at best very limited.

The vibrations of sound provide information of a more comprehensive kind, once ears were evolved to receive them; yet even the records of hearing are relatively vague and unlocalized as contrasted with the records of vision. The range of sound waves is also limited. Sound covers only 1,040 feet per second, while light traverses 186,000 miles of space in the same time.

Sound requires a substantial medium in air or liquid or solid; light voyages in the ether.

Consider how largely your impressions of the world are visual impressions. How utterly changed the world would seem if you had no mental picture of things seen: no conception of light or of color. Your mind would be a blank as to entire fields of knowledge. You would have only vague notions of distant objects; no knowledge of form or size or shape or texture except of such objects as you could actually touch. Yours would be a sterile and barren world—dark and pictureless—as contrasted with the world of light and color and form and distance.

Such must have been the world of all creatures before eyes were evolved. But eyes came early in the scheme of evolution.

The Eyes of Lower Animals

The earliest plan for making possible both near and far vision was, however, somewhat more primitive than the one finally evolved. In the eye of the fish the crystalline lens is spherical, and when the eye is at rest the focus is on nearby objects, instead of on distant ones as in the case of man and the higher animals. If the fish wishes to scrutinize distant objects, its spherical lens is moved backward in the liquid of the eyeball, thus changing the focus precisely as it is changed by contracting the bellows of a camera. But the movement is limited, and the arrangement cannot give anything like so wide a range of focusing power as is possible with the perfected lens of mammals and man.

In the amphibia, of which the frog is a familiar representative, the eye is still fish-like, in that focusing is done by shifting of the lens. The ciliary muscle first becomes fully developed, and assumes its function of changing the shape of lens, in the eyes of reptiles, which are the next higher order of creatures in the zoölogical scale.

The eyes of all mammals are identical with those of man in the method of manipulation of the focusing apparatus; that is to say, focusing is accomplished by changing the shape and not the

position of the lens. But, whereas the lens itself is flattened, like that of man, in diurnal animals, it is spherical in nocturnal and aquatic animals. In the nature of the case, animals that prowl by night, and those that inhabit the water, have a relatively restricted range of vision. Their eyes must for the most part be used in viewing objects near at hand, so doubtless it is to their advantage to have a crystalline lens that is more of a microscope than a telescope.

Probably it would be to man's advantage, under the conditions of modern civilization, if his lens could revert somewhat toward the spherical type, since so many people nowadays are obliged to wear convex lenses.

Binocular Vision

The building up of brain records and mental impressions from sensations received through the eyes, on the part of our remote ancestors, must have become more and more precise as the eye was perfected, and increasingly varied as the evolving races found new environments and were subjected to new conditions. Swiftly moving creatures, particularly those that hunt or are hunted, obviously need sharp vision for objects at all distances: their lives depend upon it.

And if you have been much in the open, you will not question that birds and animals in general have good eyes.

There is one really important difference, how-

ever, between the type of vision of birds and all lower orders of mammals and the vision of men. If you look at a bird you will see that its eyes are set on opposite sides of the head, and hence must receive totally different images at a given moment. A bird cannot look at any object with both eyes at once. The same thing is true, in greater or less measure, of most mammals.

It is only creatures of the monkey tribe that share with man the capacity to fix both eyes on the same object and bring the two images into such harmony that they are registered in the brain as a single image.

This so-called binocular vision is not without its disadvantages. The eyes of a bird sweep all horizons at a glance, and may make it aware of the approach of an enemy from any direction. And for a creature subject to attack on all sides this is obviously an advantage. Seeing in all directions is less important when the bird is one that habitually hunts and is not itself hunted; and so we find that in the case of eagles and hawks, and even more conspicuously in the case of owls, the eyes tend to assume a forward location in the head, limiting somewhat the range of vision but making it possible to see the same object with both eyes at the same time,—not to see it clearly in a single image as the human eyes do, but nevertheless to gain such a double view as will give a clear notion of the distance of the object.

This is obviously important for such creatures as the hawk and the owl, which must be able to

pounce upon their prey and strike out with their talons at precisely the right moment in seizing it.

It is for this reason, doubtless, that the eyes of predacious mammals are placed relatively near together in the head, to permit binocular vision; whereas the eyes of creatures that are hunted are placed at the sides of the head, to give wide vision at the expense of concentration.

Contrast the face of a cat with that of a mouse, by way of illustration. For the cat, it is important to be able to locate the precise distance of its prey as it springs; but for the mouse what is chiefly important is to be able to discover an enemy in any direction rather than to gauge the precise distance of the enemy.

What Double Vision Accomplishes

The advantages of binocular vision, however, for a creature of developed intelligence, and in particular for one whose habits bring it in contact with new surroundings from time to time, are very striking.

Not only the distance of objects but their form is revealed by binocular vision as it could not be when the view is that of a single eye.

It is obvious that your two eyes, when focused on a given object fairly near at hand, do not receive precisely the same image unless the object focused is a flat surface. If you look at a book lying on the table in front of you in such position that you see the back and one side and the end in

perspective, you gain a perfectly clear notion of that book as a structure having three dimensions, and the reason you do so is because the right eye gets a slightly different view of the book from that gained by the left eye,—a fact that you may readily verify by closing first one and then the other. Otherwise stated, your vision, when you look with both eyes, is stereoscopic.

You are therefore constantly gaining impressions as to the precise form of objects, and these impressions are stored away in your brain and form part of the sub-structure of an important aspect of your mental development.

At the same time that your eyes give you definite impressions as to the shape of objects, they give you precise impressions also as to the distance of any object on which you focus, because your two eyes must be made to turn toward each other in order to focus on a nearby object. You are not ordinarily conscious of this effort, yet it is registered in your brain, and the difference in effort required to focus on nearby and on far-off objects is interpreted as determining the actual distance of the object, even though it be located on a plane surface.

You can, for example, judge with a good degree of accuracy the distance of a printed page held before your eyes, provided you look with both eyes. But you can judge much less accurately if you look with a single eye.

But, of course, there is no gain without the possibility of attendant loss, and binocular vision

adds some complications to the visual apparatus that give opportunity for maladjustment. If, for example, the muscles that control the movements of the eyeballs fail to work in harmony, the eyes will tend to act independently, and while this would answer very well for a bird or a dog, it will not do at all for a man, and the condition must be remedied by surgical procedure.

Again, it is essential with binocular vision that the two eyes shall focus exactly alike; yet in point of fact no two eyes ever are identical. Usually the difference is not so great that it is noticed, but very often there is enough difference to cause constant, even though unrecognized, eye-strain.

The two eyes then try constantly to adjust themselves to each other, or else one gives up the task, and leaves all the work for its stronger or less aberrant fellow.

Eyes Out of Focus

The aberrations that disturb the focus and cause abnormal vision may depend on anomalies of the eyeball itself, or of that wonderful mechanism, the crystalline lens.

Thus, the lens may be too thick or too thin for the eyeball in which it is adjusted, in which case its possessor is "near-sighted" or "far-sighted." Or it may be asymmetrical, in which case the image it casts is distorted and its possessor suffers from lenticular astigmatism. The same defects of vision may result, as we have seen,

if the ball of the eye itself is too short or too long or asymmetrical. In either case, the rays of light will not all focus properly, even if some of them do.

Yet again, the lens may come to lack resiliency; it may harden and lose its responsiveness. This is very likely to occur with advancing age; and everybody knows that elderly people often have good distant vision but are unable to focus on nearby objects. Artificial lenses easily remedy these defects. But a far more serious—and fortunately also a far less common—concomitant of old age may come in the form of a clouding of the lens, developing finally a milky opacity that shuts out the light altogether.

This condition is called cataract. It causes partial or total blindness, that is incurable except by removal of the lens itself. Fortunately, however, this is an operation that involves no difficulties for the trained ophthalmic surgeon.

You may cut off the antenna that bears the eye of a crustacean—say a crab or lobster—and a new eye will grow to take the place of the old one. But the specialized tissues of higher animals are not thus restored, and the lens once gone is gone forever. The transparent fluids of the eye will take its place, but its function of refracting light and bringing it to a focus on the retina must thereafter be performed by heavy convex glasses. With the aid of these, however, a good degree of vision may be given to eyes that are totally blind before the removal of the cataract.

Eye Defects that We Nearly All Have

These surgical cases, however, do not so much concern you as do the more usual defects of refraction already referred to. These, under conditions of modern life, are all but universal.

The eye that is called upon to focus on fine print, page after page, is subject to a strain that in a sense is abnormal; for the ancestral eye was chiefly employed in long-distance work, as became the eye of the fisher, the hunter, and the husbandman. And the structure of such an organ cannot be radically changed in a few hundred generations. Reading, as applied to people in general, is a very modern habit. Only two or three generations ago half the women of England, and a large number of the men, were obliged to make their mark in witnessing their marriage contracts. Universal literacy, applied to the masses in general, is a social development of the nineteenth century.

So it is almost a matter of course that the modern eye yields habitually to the abnormal strain, and cries out for aid.

If aid is not forthcoming, messages of distress are sent to the brain that are interpreted as headaches, irritability of temper, and the like. Meantime, the eyes themselves become inflamed, or through the excessive muscular action required in focusing they assume a permanent condition of "squint," which the specialist terms strabismus. Short of this, the strain may produce weariness of

brain, and the defects of vision may be instrumental in retarding the progress of the child, when the very existence of the defect is unsuspected.

Thousands of children pore over their books without ever being able to see clearly a single letter; they themselves quite unconscious that their vision is not normal, and their parents and teachers equally oblivious. Such children carry a needless burden.

Take steps to find out if your child is of this number. If you have reason to suspect abnormality of vision, have the matter decided by a competent physician; not by a spectacle vendor or optician whose legitimate business is merely to make glasses on prescription, not to write the prescription itself.

For those who cannot afford to pay a physician, there are clinics where the most skilful attention is given free of charge.

How the Tests Are Made

When the oculist tests your eyes, he places you with your back to a light and reflects the light through your pupil with a little concave mirror called an ophthalmoscope.

This instrument was invented by the celebrated German physicist, Helmholtz. Its user looks through a small hole in the centre of the mirror,—a simple but ingenious device that enables him to look into the depths of your eye and see the surface of the retina as if it were on the outside.

Lenses of different curvature adjusted in the mirror enable the user to determine the curve of the retina and to detect any departure from the normal. It is possible also with the ophthalmoscope to observe the condition of the blood vessels in the retina, and thus to detect other abnormalities than those having to do with refraction.

After the test with the ophthalmoscope has given a fairly accurate idea as to the errors of refraction, further tests are made with lenses of different curvature, in which your own observation supplements the results of the ophthalmoscopic examination.

With young people in particular, the action of the ciliary muscles is so persistent and the constriction of the iris so marked under the influence of light that it is necessary to use atropin or its modern derivative homatropin to relax the muscle and dilate the pupil.

Under these conditions the crystalline lens assumes what may be considered its normal shape, and the large aperture of the iris makes full view of the retina possible. As the muscle that normally changes the shape of the lens is temporarily paralyzed, the tests will show the refractive conditions, uninfluenced by any voluntary effort on the part of the patient. It is thus possible to make a more accurate and reliable test of the actual conditions of refraction than could be made while the ciliary muscle has normal action and is persistently trying to focus.

The prescription which the oculist writes seems

mystifying to the average layman. Its " O. D." and " O. S.," however, imply nothing more than " right eye " and " left eye "; and the mysteries of its formulæ may be summed up in the statement that the lenses for which it calls are either plainly spherical, concave or convex (their power designated in " diopters ") or are ground on a cylindrical foundation, the axis of which is so adjusted as to correct the asymmetry of the cornea or lens or eyeball that causes the condition known as astigmatism.

A large number of individuals suffer from this condition, and hence have blurred vision, without ever recognizing their defect.

It has been suggested that a modern school of impressionistic painters owes its origin to the fact that the master suffered from astigmatic vision, and saw objects at a distance less clearly than people of normal vision see them.

Be that as it may, it is obviously desirable that you and I should see objects about us as they are, or at least as other people see them. Clear vision is at a premium in many callings; and, aside from that, the relief and comfort that people with astigmatic eyes receive from properly gauged glasses is something to which hundreds of thousands of individuals could testify.

Taking Care of the Eyes

As a rule, if your eye is astigmatic you must wear the corrective lenses at all times. For the

eye once distorted in shape is seldom restored to normality. But you should clearly understand that if your eyes had been properly cared for from childhood they probably now would not have become astigmatic. Like most other permanent eye-defects, this is usually traceable to overuse or incorrect use under unfavorable conditions.

The eye of the child is usually normal in shape and function. If properly cared for it will usually remain normal.

So it becomes an important question for each of us as to what constitutes the right treatment of the normal eye.

In general, rules for hygiene of the normal eye are very simple and easy to follow out. It is scarcely more than the reiteration of a truism to say that you should not read fine print persistently, or focus on minute objects of any kind, without periods of rest. Even in reading ordinary print, you should glance up from time to time, and give the ciliary muscles a moment of relaxation by casually looking at some distant object or throwing the eyes altogether out of focus.

You cannot hold your arm extended for even a few minutes without its muscles becoming utterly exhausted. There is no reason why you should expect the muscles of your eyes to be tireless.

It is very important, too, that the eye should not be subjected to undue strain through reading a badly-lighted page. The light, on the other hand, should not be too intense. It should preferably come from behind the head or from the

side, so that the rays are not directly reflected into the eye from a brilliant electric light or Welsbach burner, but come rather in diffused rays.

In reading at night it is desirable to have the room in general fairly dark, so that the iris may be well dilated. The reading light need not then be too intense, if placed near the page it illuminates.

Under these conditions it is possible to read for hours with less strain on the eyes than would result from a few minutes of reading with a light that is badly placed or with one that is either too brilliant or too dull.

Should the eyes show a tendency to irritation or inflammation, the use of a saturated solution of boric acid, applied with the ordinary eye-cup, will almost always be of service; but such a tentative measure should not of course take the place of a radical correction of any error of refraction by the use of proper glasses.

Occupation and Eye-Strain

Of course, the character of your occupation may make it almost impossible for you to avoid overuse or abnormal use of your eyes.

Dr. George M. Gould, whose life-long exposition of the evils that result from eye-strain is well known, gave a list of occupations with reference to their average effect on the eyes in a paper before the International Congress of Hygiene at Washington. He divided the occupations into five

large groups, aggregating 114 individual callings.

The first group comprised largely persons leading outdoor lives, from hunters and trappers, lumbermen, seamen, farmers, and common laborers to gardeners, hod-carriers, quarrymen, and locomotive engineers. Only from one to twenty per cent of the persons in these occupations, according to his estimate, have diseases due to eye-strain.

The second group, including railway conductors, outside painters, carpenters, merchants and salesmen among others, shows twenty to forty per cent of cases with eye-strain diseases.

In successive groups, the percentage rises, always with the inclusion of occupations requiring more and more constant use of the eyes, particularly for nearby work, until in the fifth group, beginning with students in seminaries and colleges and with clergymen, lawyers, and bank clerks, and ending with type-setters, type-cutters, miniature painters, photograph retouchers, and etchers, the ratio of defects is given as from eighty to one hundred per cent.

In other words, persons whose occupation requires almost incessant focusing of the eyes on nearby objects, and particularly small objects, develop abnormalities of vision almost as a matter of course.

Moreover, the results of eye-strain thus introduced are not at all confined to abnormalities of the eyes themselves. Dr. Gould believes that constant straining of the eyes, particularly without

properly adjusted spectacles, is the main cause of the observed fact that telephone girls suffer from a great variety of illnesses and usually break down altogether after two or three years of service.

The report of a Royal Commissioner of Canada as to the maladies resulting from telephone operating gives a list of defects that covers almost a page of fine print. "Nervous debility, wearing down of the nervous system," "headache from looking at the holes," "inability to sleep," "fainting," and "nervous prostration and nervous breakdown" are among the conditions listed; and it is declared that "after five years the girl will be disqualified to become a wife and mother"; and the prediction is made that "on future generations the effect will be epilepsy and all sorts of nervous diseases."

In Dr. Gould's view these untoward results, and similar ones reported elsewhere, are very largely due to a single cause.

"The disorders most frequently mentioned," he says, "and most emphasized among the telephonists are nervous affections, digestive disorders, anemia, nervousness, neurasthenia, nervous debility, migrain, headaches, vertigo, palpitation, and so on, precisely those I have found in thousands of cases and for twenty or more years have demonstrated to be due to eye-strain."

Not all authorities are prepared to go quite as far as does Dr. Gould in ascribing the observed maladies exclusively to eye-strain, but no one competent to judge will doubt that eye-strain is at

least an important contributory factor in a very large proportion of cases. Nor can it be questioned that it is in the highest degree important, not merely for telephone operators but for the followers of every line of work that requires constant exacting use of the eyes, that their eyes be carefully tested and any errors of refraction fully compensated with proper glasses.

Guarding the Child's Eyes

But the most important thing of all, of course, is to safeguard the eyes of children.

To begin at the beginning you should understand that abnormal conditions of the eye are peculiarly likely to be inherited. The very common condition that leads to shortsightedness is partially due to a thinness or a lack of toughness of fibre of the structure of the eyeball itself. The muscles tugging constantly at the eyeball, particularly in focusing on nearby objects, exert such a constricting force as gradually to lengthen the eyeball, making it more or less egg-shaped; the result being that the rays of light are focused in front of the retina. Thus it becomes necessary to bring objects very near to the eye in order to see them clearly, and the straining incident to focusing at close range aggravates the difficulty, so that shortsightedness is likely to be progressive.

The condition of the eyeball that leads to this result is likely to be transmitted to the offspring.

So if either parent of a child is nearsighted, the

eyes of the child should be given careful attention. The condition of nearsightedness will probably not develop until the child is six or eight years old; but the probabilities of its development should be borne in mind from infancy, and efforts made to obviate this unfortunate result.

To that end, the child should be given large objects to play with, even in the nursery. It should have its letters taught by forming them with blocks of wood, rather than by the use of a book. Even the scanning of picture books should be discouraged, and in general the child should be prevented from scrutinizing habitually small objects or nearby objects of any kind. It should not be permitted, for example, to draw pictures, to sew, or to thread beads, or to engage in any other occupation or diversion that necessitates near vision.

Dr. Ernest Clark, the London specialist, urges that no child having the hereditary tendency to shortsightedness should be allowed to learn to write or draw until it is at least seven years old.

Dr. Gould, in the paper already quoted, declares that shortsightedness is a malady that is almost tragical in its importance to thousands of its victims. Where the defect of aberration is pronounced, he says, any swift, safe, or accurate sport or bodily activity, except swimming, is impossible. The shortsighted person never dares to run, and all motions must be slow, indefinite, and cautious.

Yet all this, Dr. Gould emphatically declares is needless. " The origin of the condition of the

eye that causes shortsightedness is known and its preventableness certain. It is called simply and solely by uncorrected, by overcorrected, or by miscorrected hyperopic astigmatism,"—that is to say, an eyeball that in the beginning is slightly too short and asymmetrical and which therefore has an error of refraction that the eye strains constantly to correct.

And Dr. Gould adds: "There need not be a single shortsighted individual in the civilized world and there will not be one when the world becomes genuinely civilized."

Small Defects Are Most Dangerous

After citing such testimony, it is almost superfluous to add that, regardless of hereditary tendencies, you should make the most painstaking effort to ascertain whether your child has any error of refraction.

Above all it is important to realize that even slight errors, necessitating a constant eye-strain, may lead to most disastrous results. Indeed, it is the rather paradoxical fact that small errors of refraction are the ones most likely to cause eye-strain with its attendant evils. If the refractive error is large the eye does not try to overcome it, but if it is slight there is constant straining, usually unknown to the child himself, and the wear and tear not only on the eye itself, but on the brain centres is almost sure to produce permanent injury. This may take the form of inflammation

of the eyes, leading perhaps to granular lids or even to incurable maladies of the interior of the eye, such as inflammation of the iris, increase of the fluid contents of the eyeball, or the condition called cataract.

In other cases the symptoms may not focalize on the eye, but there may be severe neuralgia, convulsive movements of the facial muscles, attacks of dizziness and nausea, or even the convulsive seizures of epilepsy, without the real cause being suspected. Short of such tangible manifestations of nerve exhaustion, there may be a steady nerve waste that leads to perpetual brain fatigue with attendant irritability, lack of power of concentration, failure of memory, and insomnia leading to depression and even to mental overthrow.

Says Dr. Clark: "Insomnia is a prominent symptom of eye-strain; this leads to depression which in turn may lead to the alcohol or morphine habit. There is no form of functional nerve disorder that may not be caused, or aggravated by eye-strain."

Dr. Gould goes farther. Not limiting the view to functional disorders, he names curvature of the spine among common conditions due to eye-strain, the bodily distortion resulting, he says, "from the effort to focus defective eyes on books at school and the home under improper conditions as to desks and light."

"As to the millions of common school children," he says, "their ocular ills, their eye-strain, and its effect upon general health, their standing

[illegible] — [illegible] [illegible]. "[illegible] [illegible] in the United States, [illegible] [illegible] [illegible] in distress-producing postures."

"For [illegible] good school desks in the United States!" Ten, fifteen or twenty million children are forced to sit at school desks "in distress-producing postures." A dreadful indictment of our educational system. Possibly it overstates the facts; but it is not far [illegible] the truth [illegible] [illegible] [illegible] [illegible].

The Home Influence All Important

In a word, then, it is impossible to exaggerate the dangers that attend the eye-strain that may be due to a very slight error of refraction.

And the danger is peculiarly subtle because the child is quite unaware of the difficulty. It may even happen that astigmatism due to asymmetry of the cornea is corrected by such action of the ciliary muscle as will change the shape of the crystalline lens in a way to correct the distortion of the image and thereby give perfectly good vision.

But the correction is made at the expense of incessant eye-strain, which cannot fail to make its effects manifest sooner or later. In such a case it is impossible to detect the abnormality unless the ciliary muscles are paralyzed momentarily

by a drug like atropin. But the interests of the child demand that the error should be detected and corrected by the proper glasses.

In case the eye suffers from astigmatism, and in those other cases in which the two eyes have different errors of accommodation, it is peculiarly necessary that there should be complete correction of the errors, and that the correcting glasses should be worn at all times. It is possible thus to give normal vision and to remove eye-strain, obviating the danger of incurable eye maladies or permanent perversions of the nervous system.

But it is best of all to train the child from infancy to use the eyes in such a way as to preserve them in a normal condition, and thus to spare him the inconvenience of the lifelong wearing of glasses.

Wise parents are now giving heed to this matter of eye-strain even in the nursery; and teachers in the schools are coming to understand more clearly the need of proper lighting and the vital importance of using only such text-books as have large, clear type. The light of the schoolroom should come from the side, preferably the left. Desks should be so arranged that pupils can sit upright at their work, and particular effort should be made to see that they do not hold their books too near the eyes.

Let Dr. Gould's charge about the bad desks be remembered, and his warning heeded. Any child that tends constantly to scrutinize its work with eyes close to the page should at once have its eyes

examined, that its incipient shortsightedness may be corrected.

But for that matter every child should have its eyes examined by a competent occulist from time to time, just as it should have its teeth examined by a dentist. Indeed, of the two preventive measures, the former is by far the more important. If you fail to take this simple measure to safeguard the eyes of your children, you are guilty of inexcusable negligence, and the child, later in life, will quite properly resent your oversight.

VII

Do You Choose Your Children?

HAVE I the right to get married? If already married, have I the right to have children? If I have children, will they be healthy in mind and body, or will they be feeble-minded, or consumptive, or epileptic, or so sickly and defective that they will be a burden to themselves and to their parents?

The time is coming when every intelligent man and woman must ask himself or herself such questions as these,—direct, personal, practical questions. The new knowledge of heredity makes it imperative to do so. The long controversy about the relative influence of heredity and environment has been settled for all time. We know now that the possibilities of any individual are predetermined before birth. When you select a marriage partner, you are predetermining the character of your offspring almost as clearly and as definitely as an architect is predetermining the character of a building when he selects steel or wood or stone or brick or concrete as building material.

If your child has a wrong heredity, you can no more make him a normal and healthy and clear-minded individual than you can make a mar-

ble palace out of bricks or a brick house out of wood.

Environment and education can do something, but at best they can only supply a veneer. The essential constitution and mind of the individual are born and not made. Such is the clear, emphatic, and thought-provocative teaching of the new heredity.

You, perhaps, are inclined to doubt this. You have seen bright, healthy, robust children in families where the parents were sickly or unintelligent or depraved. You have also seen defective children whose parents were robust and intelligent. Such observations seem to deny the influence of heredity. But the new studies explain these anomalies; explain them not by the citation of theories merely, but by the piling up of illustrative cases, by the massing of evidence that no one can ignore. If you are to select a marriage partner wisely, and to give your prospective children half a chance in life, you must be familiar with at least the essentials of this new and important knowledge.

At the very beginning it must be understood that we do not inherit our traits exclusively from our parents. We inherit them from grandparents and great-grandparents as well.

Indeed, traits of a perfectly definite character —our stature, the color of our eyes or hair, our mental abilities—may come by direct inheritance from even more remote ancestors after skipping two or three generations. The present writer,

for example, has an extra tooth, an extremely rare phenomenon. One of my cousins also has an extra tooth. No one of our parents or grandparents had teeth different from the normal; but investigation has revealed the fact that one of our great-grandparents had an extra tooth. This peculiarity, then, is a family trait which, could we trace it, would doubtless be found reappearing here and there throughout the whole line of ancestry.

What is true of this tangible but unimportant characteristic is equally true of every other physical and mental trait, from the most obscure and incidental to the most prominent and essential.

It may fairly be assumed that no individual has any trait of body or mind that was not clearly and definitely present in one or another of his ancestors. Your child has certain traits and capacities that no ancestors of yours have had, to be sure; but you must recall that your child has two parents and that both ancestral lines affect it equally. Your child has twice as many ancestors as you have.

In other words, your marriage partner brings an endowment of characteristics, good or bad, that are weighed against the characteristics of your ancestry in determining the personality of your child.

And that is why the selection of a marriage partner is far and away the most momentous task that you can by any possibility be called upon to perform.

The New Knowledge of Heredity

It is no new thing, of course, to say that the personality of any individual represents more or less clearly the sum of the personalities of all of his ancestors. But the new studies of heredity show that the diverse characteristics of the many ancestors are not blended in the way they were formerly supposed to be blended.

Each individual is now thought of not so much as representing a blend of traits as a mosaic. The new studies show that there are many characteristics of both body and mind that do not tend to become modified through blending, but which may seem altogether to disappear in a given generation, or even for successive generations, and yet reappear with full force in a remote descendant.

This means that each individual bears within his system and may transmit to his descendants a multitude of characteristics that he gives no evidence of having and of which he is quite unconscious. Just what these latent characteristics are can be known only through study of the characteristics of our forebears.

Did you ever stop to reflect what a complex structure the so-called ancestral tree really is?

A moment thought's will make it clear that every individual has an ancestry that doubles with each generation as we go back. Most of us know the names of our grandparents; but few of us can name offhand all eight of our great-grand-

parents, to say nothing of the sixteen members of the preceding generation, or their thirty-two parents. The great-grandparents of your great-grandparents were sixty-four in number. They lived at about the beginning of the eighteenth century, so that does not carry us very far back. Yet I venture to say there is not a man in America who can name or trace all the members of his ancestry of that generation. It would be well for us all, in the light of the teaching of modern heredity, if we could.

Every one of us has (or would have were it not for inter-breeding) 1,024 ancestors of the tenth generation; and that carries us only to the time of the Pilgrim fathers. Who pretends to know anything whatever about one in a hundred of these?

Not even the crowned heads of Europe—neither Kaiser Wilhelm, King George, nor Alphonso—could name, with the aid of all existing records, the full list of their ancestors of that tenth generation—only three hundred years ago.

Yet each one of the thousand had individual traits that are present, patent or latent, in the germ-plasm of his descendant of to-day. As a single illustration, note the Hapsburg lip, which Alphonso has inherited from a known ancestress (Cymburga) of the fourteenth century.

In a word, then, each of us is the bearer of a message from our ancestry to our posterity.

You stand at the meeting point between galaxies of ancestors and other galaxies of prospective

progeny. In your system lies the bit of germ-plasm that—miracle of miracles!—conveys the potentialities of good and evil of all the past—the epitome of the racial history of all your myriads of ancestors.

Nothing that you can do will change the character of that germ-plasm. Its potentialities are fixed irrevocably. In a sense it is not a part of you; it is a heritage placed temporarily in your stewardship.

But it is open to you to decide whether you will be a true or a false steward. You may determine whether the progeny flowing from that germ-plasm shall be worthy of its best possibilities, or whether they shall exemplify its worst possibilities. And the whole momentous question hinges on a single decision—your choice of a marriage partner.

All the evolution of the past has been determined by mating selections; all the progress of the future will be conditioned on mating selections.

Viewed in this light, it might almost be said that a couple going to the altar stand before a court where thousands of ancestral ghosts sit in judgment, ready to chorus approval or to forbid the unworthy banns. It would be well for the world if our dull human ears could hear the verdict—for none but the most foolhardy would dare to ignore it.

It is not necessary, however, to invoke the galaxies of past or future to show the all-importance of the marriage selection. It is quite enough to

appeal to your own personal and selfish interests. However slight your interest in the welfare of remote posterity, you at least are concerned about the welfare of your children, and that is the topic at present in hand.

The Conflict of Tendencies

The central fact to get clearly in mind is that in your germ-plasm are mingled the relics, so to speak, of very diversified ancestors. It is obvious that many of these traits are antagonistic or mutually exclusive. For example, you cannot be both tall and short. You cannot have both dark hair and light hair; or black eyes and blue eyes. You cannot be strong and weak; healthy and unhealthy; sane and insane. Yet your two parents may represent these and a multitude of other divergent traits.

Take, for example, the simple case of two parents one of whom has black eyes (of a pure strain) and the other blue eyes. It is matter of observation that in such a case the children all have dark eyes. But it is further to be noted that these dark-eyed offspring, mated with other persons of similar heritage, have a certain proportion of children with blue eyes.

Thus the tendency to blue eyes, although subordinated and as it were overriden in one generation, reappears in the succeeding generation.

A striking illustration of the same thing is obtained when a black guinea-pig is mated with a

white guinea-pig, as in Professor William E. Castle's experiments. All the offspring are black. Yet these black offspring when interbred produce a certain number of white guinea-pigs,—one in four, to be explicit. It is obvious, then, that the black guinea-pigs of the second generation have latent in their systems the tendency to whiteness. The tendency to blackness prevailed so far as the individual was concerned; but the opposing tendency was only temporarily subordinated.

A multitude of observations have shown that the great variety of traits that go to make up the physical and mental characteristics of human beings are weighed against each other and transmitted as patent or as latent characteristics.

It is obviously important to ascertain, particularly as regards diseased conditions, which traits tend to be directly transmitted from parent to offspring, and which ones tend to disappear in a generation and reappear in a later generation. Enough facts as to this all-important matter have been collected in very recent years to afford a basis for the scientific selection of marriage partners.

We now know that in many cases seemingly normal individuals could not be mated without entailing the gravest danger upon their progeny.

Ancestors and Marriage Partners

Let us make the illustration concrete. You are, let us say, a young man of seemingly good health,

and entirely normal in mind and body. You have fallen in love with a young woman also sound and healthy. Both of you could pass the most rigid life insurance examination. Seemingly you are well suited for each other.

It is true that one of your great-grandparents was mentally unbalanced, but there is nothing very startling in that, for investigation shows that there are strains of insanity in about one-third of all families. Your parents and your four grandparents were of normal mentality. So why give the matter a thought? In point of fact, you need not, were it not for the fact that one of your fiancée's grandparents was subject to epileptic seizures. But if you are wise that fact will make you pause. Insanity and epilepsy are not the same thing, to be sure; but they are allied neuroses which operate in the same way in the scheme of heredity.

It is more than likely, then, that the two neurotic taints if brought together will act like fire and tinder; and your offspring will be neuropathic,—feeble-minded or epileptic or sexually perverted or destined to become insane.

So your contemplated marriage involves matters far more profound than the mere question of your individual happiness of the moment. It involves the weal or woe of those years of the future when your children will be to you either the supreme blessing or a source of the profoundest remorse and sorrow. Dare you take the hazard?

Before you answer, look about you, and consider the families of your neighbors. More than likely some of them include children that are congenitally crippled or scrofulous or "backward" or vicious and depraved. You have supposed that this was an unavoidable misfortune; an inexplicable "interposition of Providence." You are wrong. The seeming misfortune that is bringing the head of your neighbor in sorrow to the grave was really of his own choosing. He predetermined that his child should be neuropathic or epileptic or deformed or congenitally blind or deaf or morally depraved when he selected the mother of that child. He made the choice unwittingly of course. But nature makes no allowance for ignorance.

You will invite the same disaster if you act with like lack of foresight.

There are estimated to be four million children in the United States that are classified as "exceptional." The Binet tests show that in some of our schools 30 per cent of the children are below the normal standards of mental development. Do you wish to be responsible for children that will add to this class?

There are estimated to be 200,000 individuals in the United States that rank as imbeciles. And with the rarest exception the cause of imbecility is heredity—and heredity alone. The parents of an imbecile may be mentally sound and normal; but they carry inherited defects in their germ-

plasm or their child would not be congenitally defective.

And this, be it understood, applies to moral defects no less than to mental. Hereditary instability of the nervous mechanism—weakness of brain and mind—may reveal itself differently in various members of the same fraternity—in one case as feeble-mindedness, in another case as criminality, and in yet others as epilepsy or as insanity or drunkenness or debauchery.

Such details of difference as these imply are often determined by the environment; but the deep-seated nervous defect that underlies them all is a matter of inheritance.

Your Family Tree

All this, you admit, is very harrowing; but you thank your lucky stars that your family is free from any such taint.

Do not be too sure of that. Do you know the names, let alone the antecedents, of your eight great-grandparents? Are you quite sure that no one of them was consumptive, or addicted to alcohol, or the victim of venereal diseases? One-tenth of all deaths are due to consumption. So it is more than an even chance that your forebears of the past three generations included at least one victim of this disease.

If such is really the case, there is a strain of susceptibility to the attacks of the tubercle bacillus in your system—bred in the bone, as the saying

is—however free you may be from any outward indication of the fact. And the one sure way to bring that latent tendency to the surface, is to choose a mate who carries the same latent hereditary tendency.

Look about you and see how many of your acquaintance, themselves healthy, have scrofulous or nervous or ill-nourished, pale, sickly children. Then ask yourself whether you would knowingly choose such progeny for your own.

The choice lies with you. If you mate with a person of a family strain not susceptible to tuberculosis, your children will in all probability be normal in this regard. Even the children of a consumptive who mates with a normal person may be normally resistant. But to unite two tainted strains, even when the individuals themselves are normal, is to challenge fate; in effect, to invoke a curse on your own progeny. "It is highly undesirable," says Professor C. B. Davenport, "that two persons of weak resistance (to tuberculosis) should marry, lest their children all carry the weakness."

If that simple rule could be known to people in general, and if they could be prevailed upon to act on it, how rapidly would the fight against the great white plague be carried to a successful issue.

Unfortunately the time has not yet come when we can hope that the average young man and woman will consider such teaching as this against their own individual fancies of the moment. But

you and I, being rational persons and able to match future happiness against momentary pleasure, may ponder this teaching of the new heredity to our own benefit and that of our prospective children.

Some Thought-Compelling Cases

And all this, be it understood, is no mere theorizing. It expresses probabilities based on the study of actual pedigrees. Other pedigrees that have been studied include a wide variety of diseased conditions.

Here, for example, is a case in which a healthy, normal man and woman marry, without so much as giving a thought to the fact that the father of each had died of heart disease. But was it an accident that of the four children born to this couple two had heart trouble, and one died of heart disease in infancy?

"Heart disease," says Professor Davenport, "is very common, but it does not fall upon individuals at random, but prevailingly upon strains with an inherent liability or weakness."

The same thing is true of other anomalies of the circulatory apparatus. There are, for example, families of "bleeders," persons whose blood does not coagulate normally, so that even very slight wounds expose them to grave danger from hemorrhage. This disease has the peculiarity that it usually affects only the males of the family, yet is transmitted only by the females; that is to say, a man who is a bleeder will

have normal children, but his sister, although personally normal, will have sons that are abnormal. Here is a pedigree in which, in a fraternity of five members, the three men are all bleeders. The two sisters are normal; yet when married to normal men these women have respectively four and five sons, all of whom are bleeders.

The mothers who thus transmitted a condition that was latent in their own systems had normal parents and grandparents; but one of their great-uncles was a bleeder, and the hereditary character of the infirmity is further attested by two afflicted cousins and by a total of twenty-five bleeders in closely collateral lines in the course of three generations.

This pedigree, and others like it, justify the conclusion that whereas male bleeders may marry with relative impunity, their sisters, though themselves normal, should not have children. The verdict seems harsh, but it is rational.

A similar tendency to "crossed-heredity"—that is, transmission from mothers to sons, or from fathers to daughters—occurs in connection with a good many abnormalities of the eye.

Thus color-blind men do not have color-blind sons, and as a rule their daughters are also normal. But these normal daughters, married to men of normal stock, have color-blind sons.

Similar anomalies of inheritance are found in cases of the much more serious eye defect called coloboma, in which the iris fails to develop normally, and in the condition that leads to total blind-

ness through atrophy of the optic nerve. It is declared with authority that " no female with the coloboma defect should have children, since all sons will be defective in the structure of the pupil. For males with the defect the danger in marriage is also great, for either all or half of the sons of such a father, although married to a woman from a normal strain, will be defective, but the daughter will not be defective in this respect unless the wife belongs to a strain with this defect."

For families having the tendency to atrophy of the optic nerve the rule given is this: " A normal son of an abnormal male may marry quite outside the family with impunity, but a normal daughter may transmit the defect to her sons. A defective male should abstain from having children, for some of his sons, at least, will probably be defective."

Even the most heedless person can scarcely fail to pay attention to such a warning as that. The possibility of producing children that are blind—and doing this wilfully in defiance of the teachings of heredity—is one that no sane person could contemplate with equanimity.

The Marriage of Cousins

Consider now a pedigree that introduces another complication. A young man falls in love with his cousin. Both are normal; so are their four parents; and they ignore the fact that one of their common grandparents was deaf. The two

cousins marry and have four children, of whom two are born deaf.

Here the hereditary defect has skipped two generations, and there is reason to suppose that it would not have reappeared but for the union of cousins. The justification for this belief is found in the fact that deafness may be due to a good many different conditions, so the marriage of unrelated deaf mutes results in deafness in only about one-fourth of the offspring, the low percentage being due, Professor Davenport believes, to the fact of one parent bringing into the combination what the other parent lacks, thus neutralizing the defect. But when the parents are related—belonging therefore to the same type or strain of deafness—the percentage of marriages yielding deaf children increases in proportion to the closeness of relationship of the parents.

In one case in which the marriage partners were nephew and aunt, 75 per cent of the children were deaf.

It must not be supposed from this, however, that there is any peculiar association between deaf-mutism as such and consanguineous marriages. A great variety of defects may be brought to the surface in the same way. Thus Dr. Bemiss (cited by Davenport) reported 833 consanguineous marriages having 3,942 children, of whom about one-fourth died young, and of the remainder more than 1,100 were "defectives," including deaf mutes, the blind, idiots, insane, epileptics, and the deformed and scrofulous.

Dr. Howe reports seventeen consanguineous marriages that produced 50 per cent of idiots.

The point is that any defects in the germ-plasm tend to reveal themselves in the offspring of cousin marriages. Here is a family in which there is no known taint, but in which it becomes the fashion for cousins to marry. In the first generation under observation healthy cousins marry, and the second generation shows one individual in three suffering from the condition of muscular lack of tone and responsiveness known as Thomsen's disease. Three cousin marriages occur in this second generation, five of the six partners being normal. But in the ensuing generation, of eight children born to the three couples four have Thomsen's disease, two have nerve and lung trouble, and only one is normal.

Here the cousin matings brought out a strain of abnormality that had so completely disappeared that its existence as a family trait had been forgotten.

Illustrations of the evils of cousin marriages may be found on a large scale in every community where physical barriers to migration or social restrictions have led to much intermarrying. In Martha's Vineyard close inbreeding has led to the prevalence of deaf-mutism; in Point Judith to idiocy and insanity; in an island off the coast of Maine to "intellectual dulness"; in Block Island to loss of fecundity; in some of the "Banks" off the coast of North Carolina to suspiciousness and mental feebleness; in a peninsula on the east

coast of the Chesapeake Bay to dwarfness; in some of the Bahamas to idiocy and blindness.

"Thus," says Davenport, who reports these instances, "there is no one taint that results from the marriage of kin; the result is determined by the specific defect in the germ-plasm of the common ancestor."

It follows that if there is no hereditary weakness in your family—no taint of mental or physical disease—you may marry your cousin without jeopardizing the interests of your prospective offspring. But if there is a heritable taint—and very few families are altogether free from one defect or another—you magnify the defect by the union of two strains that carry it. A totally unrelated person *may* have the same defect; but your cousin is almost *sure* to have it, because you inherit from the same ancestor.

So the marriage of cousins should never be consummated without very careful scrutiny of the common pedigree.

The Individual and the Race

When the marriage of persons related in some degree of cousinship is in question, it is well to recall that the entire population of a country that has been long inhabited and not much subject to immigration, comes to be made up of closely interwoven elements.

To see how inevitable this is, we have only to recall that the descendants of a single individual,

were each of his progeny to have on the average five children, amount to more than eight million in the tenth generation. Ten generations span little more than three centuries; so the total population of America to-day might be accounted for as descended from a dozen couples or so that came over in the *Mayflower*—provided there had been no intermarrying. But it is equally obvious that marriage partners could not have been found for the successive generations without constant intermarrying.

In point of fact, all students of genealogy know that where a population is established in a restricted territory a few generations suffice to make the entire community related within recognized degrees of consanguinity. In such communities, family traits and any heritable weaknesses become accentuated. The "racial characteristics" of New-Englanders, for example, and of Virginians, furnish illustrations in point. In the long run the laws of heredity operate to bring to the surface the undesirable latent traits, which, when they become sufficiently preponderant in the community, tell of racial degeneration.

Nothing saves a closely inbred race that has reached this stage except the infusion of good new blood from outside.

But in view of this intermingling of descendants, in virtue of which everyone in a given region becomes more or less closely related to everyone else, how does anyone escape being tainted with a variety of heritable defects? Until very re-

cently no one could answer that question in anything but the vaguest way, but the new studies of heredity have supplied a perfectly definite and precise answer, the gist of which is that the same traits are not transmitted to all the offspring of a given couple, and that by proper selection even the worst defect may be bred out of a family.

The Same Laws for Animal and Man

To make the matter clear, we may draw an illustration from the animal world. It is quite valid to do so, because it is fully conceded that the same laws of heredity apply to animals and to men. Indeed, the knowledge that is now being applied to human matings was first gained by experiments with plants and animals. It will be recalled that the new methods of treating human diseases were discovered in the same way.

Let us take, then, the case of the guinea-pigs already referred to. We saw that if a black and white guinea-pig, both of pure strains, were mated, the offspring are all black. We saw further that if a pair of these offspring of the first filial generation are interbred, the progeny show three black individuals and one white in each group of four. It remains now to follow up the experiment.

It appears, then, that if the white members of the fraternity are interbred, they will produce only white offspring. They are to all intents and purposes of a pure white breed. Notwithstand-

ing the fact that both their parents are black, the tendency to blackness has utterly disappeared from their germ-plasm.

If meantime the black members of the fraternity are interbred, it will presently be revealed that, whereas they all look alike, there are deep-seated differences between them. Certain among them, if interbred, will produce only black offspring. Regardless of the fact that one of their grandparents was white, all tendency to whiteness has disappeared from their germ-plasm. But there are others among the black members of the fraternity which, if interbred, produce both black and white offspring, in the proportion of three to one. Their germ-plasm, like that of their parents, contains elements of both blackness and whiteness.

This seems remarkable enough; and the wonder grows when we learn that however often the experiments are repeated the same results are obtained generation after generation. Of any four grandchildren (on the average) of a black and a white guinea-pig, one is pure black, with no tendency to whiteness; one is pure white, with no tendency to blackness; and two are individually black, but with a latent tendency to whiteness that will make about one-fourth of their offspring white.

Thus it appears that the offspring of the same parents—brothers and sisters in the same litter—differ radically from one another not only in their personal traits, but in the latent traits carried in their germ-plasm. Some are pure black, some

are pure white, and some are mixed; and the same law of heredity accounts for them all.

Now for the application. It appears that most of the heritable human traits we have all along been considering act in inheritance precisely as do the qualities of blackness and whiteness in the guinea-pig. As regards a large number of conditions, normality may be said to be matched against abnormality as black is matched against white in the animal. When a normal person mates with a feeble-minded person, for example, the children are likely to be normal, but with a latent tendency of abnormality. Of the offspring of these children (mated with others of similar heritage), out of each group of four, one will be purely normal, two will be seemingly normal but with a latent tendency to transmit abnormality, and one will be abnormal.

Thus it appears that three out of four of the grandchildren of an imbecile, may be altogether normal, and that one of the three may have not even the latent tendency to the affliction of their grandparent. The other two have the latent tendency, but it need never reappear in their offspring if they mate with normal persons.

And this fact is, on the whole, the most wonderful, as it is the most beneficent, revelation of the new heredity.

In effect, good health preponderates over ill health in transmission; a trait that has been bred into your family through the injudicious mating of an ancestor may be bred out for all time by

judicious mating. In the course of three generations purely normal strains may be developed from families that were permeated with abnormality. And to accomplish this, nothing more is required than the judicious selection of marriage partners.

But, on the other hand, the selection of wrong partners results in abnormal children with equal certainty. Dr. H. H. Goddard, of the Training School for Defectives at Vineland, New Jersey, has gathered a mass of evidence showing that the mating of two feeble-minded persons produces only feeble-minded offspring. Similarly Drs. Cannon and Rozanoff, of the Kings Park Hospital for the Insane, find that when both parents have any form of "functional" insanity, "all of their children will 'go insane.' If one parent is insane and the other normal but of insane stock, half of the children tend to become insane. When both parents, though normal, belong to insane stock, about one-fourth of the children become insane."

Thus these practical studies emphasize anew the lesson that *everything* depends upon the matings.

New Tribes of Plants and Animals

These all-important laws of heredity have been understood only in very recent times. A clue to their interpretation was gained through study of hereditary transmission of a great variety of characteristics in plants and animals. The pioneer work was done by the Austro-Silesian

ments with fowls; and Professor Castle at Harvard, has elaborately tested the hereditary characteristics of mice, guinea-pigs, and rabbits.

By utilizing the knowledge thus gained, it is possible to produce new breeds of plants or animals in the course of three generations. Thus Mr. Woods, of Cambridge, England, by crossing a white-faced race of horned sheep with a black-faced hornless race has been able to produce a white-faced race without horns.

Professor Biffin, also of Cambridge, has crossed two strains of wheat, one of which produced large kernels but was susceptible to the plant disease called rust, whereas the other produced small kernels but was insusceptible to this disease; and in the third generation has produced a new breed combining large kernels and resistance to disease. It is estimated that the production of this new breed of wheat will save the British farmer many million of dollars annually.

But all such experiments are of course of insignificant value compared with the direct study of the heredity of human characteristics.

To secure data as to these, the Department of Experimental Evolution of the Carnegie Institution, with Professor C. B. Davenport at its head, has for some years been collecting human pedigrees. These records are the chief source of what is now known about the heredity of diseased conditions; and already they are sufficiently collated to afford an invaluable guide in the practical matter of the selection of marriage partners.

Salvation Through Wise Selection

In the light of the new knowledge, the message of heredity is not fatalistic.

It is true that your tendencies and mine were fixed irrevocably before birth. From that conclusion there is no escape. You may have inherited a family taint that your brothers and sisters have escaped. But it does not follow that you must pass that taint on to your children. On the contrary, as we have seen, the traits of your prospective offspring are to be determined very largely by your own choice.

If you wish to have strong, healthy, sane children, it is (barring a few exceptional cases) open to you to have such children. You make the choice when you select a marriage partner.

That is the inspiring, the wonderful message of the new heredity. It shows that it is largely open to your choice whether the good traits or the bad traits that are latent in your germ-plasm shall become operative in the personalities of your children. You may accentuate strains of abnormality or disease that existed in some of your ancestors, or you may eliminate such strains, accordingly as you choose ill or well. There is no sorrow like that of having offspring that are diseased or crippled or depraved. So you are juggling with your own happiness when you make selection of a marriage partner without considering the coming generation.

The new heredity does not tell you whom to

select as a parent for your children; but it can tell you whom *not* to select.

The one simple, all-encompassing rule is this: do not marry into a family that carries a defect of a kind that is carried also in your own family strain. If, for example, one of your parents died of consumption, you know that susceptibility to the tubercle bacillus is latent in your germ-plasm, even though you personally are thoroughly resistant. It would be the height of folly for you to marry an individual whose germ-plasm carries a similar taint of susceptibility, even though this individual were also personally normal.

Yet the rule may be modified to this extent in accordance with the teaching of the new heredity: if the consumptive member of your direct ancestral line was as far removed as a great-grandparent; and if you have at least three brothers or sisters, all of whom are normally resistant, you are justified in assuming that (through wise selection) the taint has been bred out of the particular strain to which you belong; and this despite the possibility that you have uncles and aunts and cousins that are consumptive.

All this refers, it will be understood, to the various abnormal conditions that tend to remain latent in a generation and to reappear under unfavorable conditions in later generations. It must not be overlooked that there are certain diseased conditions that are directly transmissible from parent to child and which, therefore, do not come within the scope of the formula just given.

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insane of New York State alone challenges public attention.

It is not pleasant to think that our children must interbreed with the children of atavistic strains of the race.

Moreover there are students of heredity who call attention to the menace of a negro population which has doubled with each generation till the 700,000 individuals of Colonial times have become 10,000,000. The very thought of miscegenation is repulsive, yet statistics show us that in some States more than 50 per cent of the colored population carries a recognized strain of white blood. Here and there the question is raised as to whether it may not become necessary to restrict the fecundity of the negro population that the intellectual status of the American race be not hampered by too large an incubus.

Your Children

All these larger racial questions have a personal bearing for each of us if rightly considered; but our present purpose concerns largely the question of the application of the new laws of heredity to the average normal individual.

It is obvious that you cannot avail yourself of the knowledge supplied by the new studies of heredity, in its practical application to your own case, unless you can gain detailed information as to the traits and characteristics, normal and ab-

normal, of your own ancestors for at least two or three generations.

In this view the study of family trees takes on new meaning. Once genealogy was a theme for the dilettante. It now becomes a study of the utmost practicality for every one of us, in our own interests and the interests of our children.

The really important question for each individual is this: How shall I set about to investigate my own pedigree?

It is obvious that ordinary genealogical tables are of little value; they fail to give precisely the information about health and disease that is most to be desired. Probably your best resource will be found in your family physician. In particular if there is in your community a physician of the elder generation, who knew your grandparents and perhaps their grandparents, his recollections and in particular his case-book records may prove invaluable. Other clues may be gained by consulting aunts and uncles or other relatives, some of whom are pretty sure to have an interest in the family history and to recall facts about the health of your various ancestors, the causes of death, and the like, that will be of value in piecing out your chart of heredity.

It is clear that such investigation of family traits as is here suggested—which becomes doubly arduous when we reflect that it must be applied also to the family of your proposed marriage partner—involves search that will often prove difficult. But when we reflect on the care with which

breeders of animals trace and guard the pedigrees of their select stocks of dogs and cattle and horses, it would seem as if intelligent human beings might be willing to safeguard the interests of their progeny with at least as much assiduity.

If you say that this seems to rob marriage of all romance, I content myself with suggesting that there is nothing appealingly romantic about a brood of feeble-minded or tubercular or epileptic children.

I would suggest, then, that every reader of these lines should undertake a personal investigation as to his own ancestry, with reference to heritable abnormalities of mind and body.

If you are in doubt as to the best method of procedure, you can secure practical information by addressing the Eugenics Record Office at Cold Spring Harbor, Long Island, N. Y. Not only will the investigators there be glad of your co-operation in securing genealogical records, but the bureau proffers its services free of charge to persons seeking advice as to the consequences of proposed marriage matings. Thus you may have the advantage of expert advice based upon the fullest collection of records of human matings and their results that is anywhere in existence; indeed, the only comprehensive set of records of the kind that has been made for its purely scientific value.

What the scrutiny of your own pedigree teaches you regarding your own germ-plasm will be useful precisely in proportion as you apply the

knowledge in the interests of your progeny. By letting your passion of the moment overmaster your judgment, you may be responsible for offspring that will rebuke you every hour of your life. By making practical application of your knowledge, you may avail yourself of the hopeful message of heredity and may give yourself reasonable assurance of such a coterie of children and grandchildren as may justly fulfil the Scriptural injunction to rise up and call you blessed.

VIII

Give Your Children a Chance

ARE you doing the right thing by your children? The question may sound almost insulting. It is not so intended. You *mean* to do the right thing of course. Your life is wrapped up in that of your offspring. But is your attitude toward them determined by wisdom as well as by right motives?

Are you aware that the entire future of your child may be vitiated by some ill-advised disciplinary act of yours?

Do you know that the physical stature of your child may be stunted by the ill-selected food you give it, and that its mental state and moral nature may be even more hopelessly dwarfed and perverted by the wrong influences to which you quite unwittingly subject it during the first three or four years of its life?

Do you realize that your failure to give adequate sex-instruction to your child in its earliest years, or your carelessness in the selection of a nurse or of child companions, may make a perverted being out of one who otherwise might have lived a useful and happy life?

These are matters that challenge your atten-

tion and lie closer than almost any others to your interests.

Unless your co-operation can be secured, all the efforts of the professional educators will be unavailing. Indeed, to a large extent the task of the educators is to undo what has been unwittingly done in the way of warping the mind of the child. The education of the school *should* supplement the education of the home; but under existing conditions the task of the school teacher is too often not to supplement but to correct.

Is your child among those who are subject to such bad influences at home that the task of rightly educating it in the school is made doubly difficult, not to say impossible?

Such are the thoughts with which you should contemplate the reports of the remarkable gathering of educators from all over the world that was in session (in the summer of 1913) at Buffalo, New York,—a gathering held under the patronage of the President of the United States, presided over by President Emeritus Eliot, of Harvard, and officially known as the Fourth International Congress of School Hygiene. The proceedings of that congress have far more vital and poignant interest for every parent than can possibly attach to the proceedings of any political body or other association concerned with the affairs of adults. For it dealt with the interests of the coming generation,—that section of the population which is always in the majority and which will control all the possibilities of the future.

Scope of the School Congress

The subjects under discussion at the Congress of School Hygiene were such matters as these: The hygiene of school building, grounds, material, equipment, and upkeep; the hygiene of school administration, curriculum, and schedule; medical, hygienic, and sanitary supervision in the class. There were symposiums organized by various national societies, dealing with such subjects as moral hygiene, school feeding, sex hygiene, tuberculosis among school children, child labor, and physical education. Among the subjects to which special sessions were devoted were fatigue and nervousness among school children, mental hygiene, play and athletics, the Binet-Simon scale, and the conservation of vision.

The spirt of the congress was well presented in a preliminary announcement by the program committee, which expressed a desire that the papers presented should deal largely with the results secured through the practical application of scientific facts and procedures of school hygiene, and with the results of scientific investigation and laboratory research.

Especial stress was laid on the desire to secure papers relating to rural hygiene, and village school hygiene,—subjects that hitherto had been sadly neglected.

The development of an international organization having such sponsors and devoted to the health of the school child is a notable sign of the

times. The great strides of preventive medicine in recent decades have led to the preservation of a vast number of infant lives that formerly would have been sacrificed, and as a natural sequel the school population has been tremendously augmented. It has been exceedingly difficult in many quarters to provide proper school-room accommodations. Undue crowding in rooms not properly ventilated or lighted has had its inevitable effects in vitiating the health of large numbers of future citizens.

But educators are now alive to the evils of the situation, and the International Congress of Hygiene will prove without doubt a reformative influence of tremendous importance.

Teachers from all over the country who attended the conferences will return to their local schools with a fund of information that will be invaluable. The results will before long be measurable in the improved health of tens of thousands of children.

Home Training

But while this movement for the betterment of hygienic conditions in the schools must be admitted on all hands to be of vast importance, the activities of the educators must be supplemented by intelligent home supervision, or their best efforts will be largely neutralized. The most perfect system of school hygiene brings its direct influence to bear on the child for only a few hours each day, whereas the home influence is perennial.

Moreover, the school influence does not begin until the most important period for the building of the individual constitution and character has passed.

Few parents realize the extent to which the physical and mental life of the adult is predetermined by the conditions of infancy and earliest childhood. It is essential that you should clearly understand that the future of your child will largely be determined for good or ill, by the treatment to which it is subjected during the first three or four years of its life. Right treatment during this period may give it a start that can with difficulty be checked even by adverse conditions afterward; wrong treatment gives it a handicap that can never be altogether overcome even under the most favorable influences of later life. The old familiar saw about the bent twig epitomizes a fundamental truth.

The Value of Mother's Milk

At the very threshold of life, a large proportion of infants are handicapped by improper feeding: Specialists are agreed that there is only one really correct diet for the infant—and that is mother's milk.

In a recent address given under the auspices of the Council of Health and Public Instruction of the American Medical Association of the Women's Municipal League of Boston, Dr. Thomas F. Harrington emphasized the fact that the subject of

infant feeding must be treated not as an ethical question alone but as an important problem of preventive medicine.

"It is an undisputed fact," said Dr. Harrington, "that certain vital tendencies which make for the welfare of the infant, such as immunity against certain infectious diseases are transmitted through the mother's milk to her child. Neither a wet-nurse's breast-milk nor a cow's milk can do this for the child."

"From 80 to 90 per cent of all deaths from gastro-intestinal disease among infants takes place in the artifically fed; or ten bottle-fed babies die to one which is breast-fed. In institutions it has been found that the death-rate is frequently from 90 to 100 per cent when babies are separated from their mothers. During the siege of Paris (1870-71) the women were compelled to nurse their own babies on account of the absence of cow's milk. Infant mortality under one year fell from 33 to 7 per cent. During the cotton famine of 1860 women were not at work in the mills. They nursed their babies and one-half of the infant mortality disappeared."

These are facts that every mother should take to heart. It seems impossible to escape the conclusion that the healthy mother who wilfully refuses to nurse her child directly threatens not merely the health but the life of her offspring.

After the child has passed the gauntlet of infancy, the question of its proper feeding remains a highly important one. Dr. Lewellys F. Barker,

of Johns Hopkins University, says that "faulty feeding in infancy and early childhood may lead to such impoverishment of the tissues and such a stunting of growth that the ill effects can never be recovered from in later life. A considerable proportion of the intellectual and moral inferiorities among our people is fairly attributable to imperfect nutrition at this early age."

Dr. Barker declares that many parents make a very vital mistake in allowing the caprice of the child to influence its diet. "We know the foods that are suitable for children," he says, "and, knowing these, the children should be provided with them in suitable amounts and should be required to eat them, largely independent of choice. The child that learns to eat and digest all wholesome foods and who is not permitted to cultivate little food antipathies makes a good start and avoids one of the worst pitfalls of life with which medical men are very familiar, namely, a finical anxiety concerning the effects of various foods, all too likely to develop into a hypochondriacal state."

While thus arguing the value of a varied dietary of wholesome foods, it is well also to emphasize certain restrictions. In particular it should be known to every parent that tea, coffee, and alcohol in any form are deleterious to the growing child and should be absolutely interdicted. This may be stated without reserve. It is a point regarding which all competent authorities are in perfect agreement.

If you allow your child to develop a taste for any of these beverages, you do it a positive injury.

New Interest in Children

Only in the most recent times has anything like a clear and full comprehension been attained, by educators in general, as to the share which home influence and education outside the schoolroom must always play in the development of mind and character, and as to the paramount importance of the child in determining the future welfare of the state.

President G. Stanley Hall, of Clark University, emphasizes this in a recent address before the American Sociological Society, in which he refers to "the remarkable new interest in childhood, which in many respects in this country had grown colder, more formal and oblivious than in any land or period in the world, but which has lately resulted in the formation of some hundred and eleven (as we classify them) organizations for child welfare and benefit, and in a renaissance of interest in work for children so great that some enthusiasts have even wanted to call this the century of the child.

"What does this recent awakening to the nature and needs of children, that is now pervading all civilized countries and has resulted in the institution of many academic chairs, laboratories, clinics, journals, and a vast and rapidly growing body of literature, really mean? It certainly

marks an extension of our social consciousness, an enlargement of our interests, and a new awakening of our duties to the young."

It goes without saying that a few leaders of thought—prominent among them President Hall himself—have long recognized the importance of the subject which is now being brought to the attention of the general public. Every experienced alienist has seen cases of profound perversion of mind, which could be traced directly to incidents of childhood.

And no wise student of the subject has doubted that every experience of childhood puts its mark indelibly upon the brain and mind of the individual.

Perhaps it seems incomprehensible to you that a fright experienced by your child at the age of two or three years can be instrumental in determining the complexion of mind of that child after it has come to adult age,—can, for example, give it a life-long inherent timidity that will dominate it under given conditions. Such, however, is the fact; and a clear recognition by every parent of this elementary truth would mark a new era in the treatment of the child, and in the social progress of humanity in general.

Says the Italian physiologist Mosso: "Every ugly thing told to the child, every shock, every fright given him, will remain like a minute splinter in the flesh, to torture him all his life long." Dr. Barker, in quoting this statement with approval, points out that "in Greece and Rome

the children were frightened with the lamias or female demons who would charm them and suck their blood, with the one-eyed Cyclops or with a block god, Mercury, who would come to carry them away." And he adds: "This very pernicious error in education still prevails. The mother, the nurse, the maid, and the servants still frighten the child with tales of the bogeyman, of goblins, or ogres, of wizards, and of witches."

Such treatment not only makes life a burden to the child, but "sometimes fears are thus started which last through life."

Dr. Barker urges that instead of thus stimulating fears, the wise parent will endeavor to teach the child to be courageous and not to have fear of being alone, or of the dark, or of thunder and lightning. Certain fears, common to childhood, he says, are easily overcome, especially through the example of courage set by parent, nurse, or teacher. There are cases, however, in which the fears are a symptom of disease.

Thus a young girl brought to Dr. Barker because of an unaccountable, persistent, and distressing fear of "burglars in the house," was found to be suffering from exophthalmic goitre. "On removal of a portion of the thyroid gland by Dr. Halsted the child rapidly improved and on last report was only occasionally troubled by the fear; it seems probable that she will soon be entirely free from it. Children who suffer from 'night terrors' often have adenoid growths in the nasopharynx; on removal of the growth by a

slight operation the 'night terrors' disappear." Bear these cases in mind, if your child is unduly timid. Do what you can to allay its fears by precept and example. And if the fears persist, consult a physician.

Actual Age and Mental Age

It has been said pertinently by a German nerve specialist, Dr. H. M. Oppenheim, that a child's childishness is its greatest asset. It is always a misfortune for children to be unduly associated with other children much older than themselves or with adults. Children who are made to visit museums, picture galleries, and the like, or listen to conversation or lectures unsuited to their years, not only do not benefit thereby, but suffer positive injury.

These things should come in their time and place and cannot advantageously be forced on the attention of the undeveloped mind.

You should never forget that the interests of your child are naturally and properly different from your interests. It is in the main normal that your children should enjoy the childish sports and diversions which you once enjoyed. So do not attempt to direct the activities of the child into channels that would be normal only at a later period of mental development. The best safeguard against this mistake is to see that the child associates largely with other children of its own age. To this end and for many reasons it is de-

sirable that the child should attend the public schools, being there brought into contact with varied personalities, and subject to the influences that will most advantageously shape its own character.

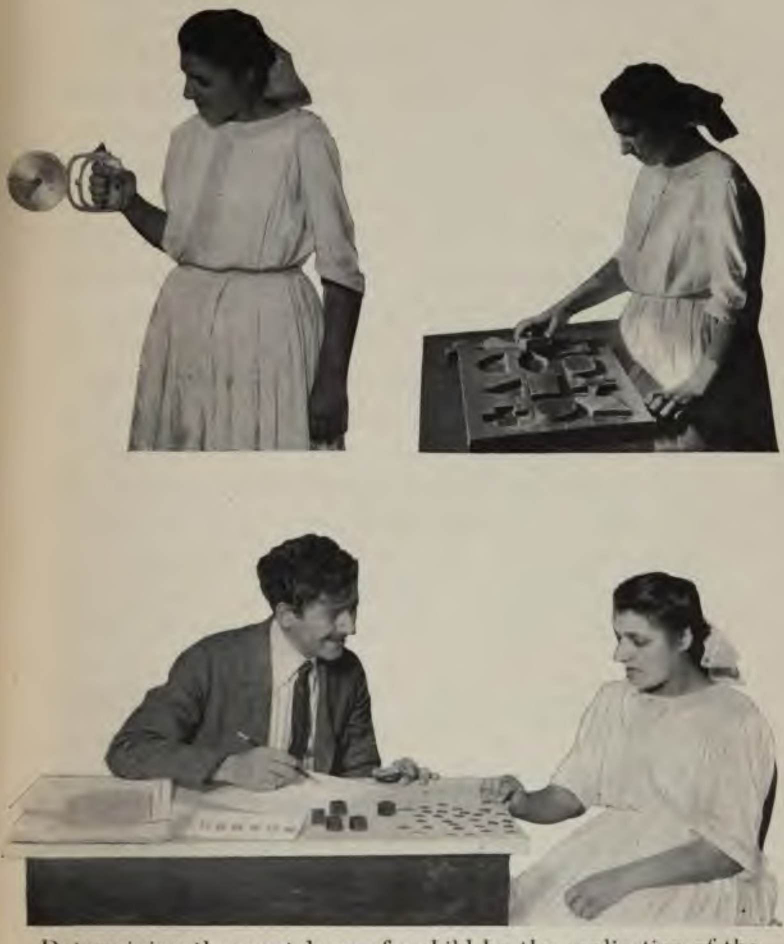
But in attempting to follow out this idea, educators have in recent years come to understand more and more clearly that there is danger of laying too much stress on the age of the child as determined by count of birthdays.

Even among perfectly normal children, some individuals develop much more rapidly than others. There is no close relation between precocity and final development of mind and body. But a failure to recognize these facts may lead to the placing in the same grade of children who are really at quite different stages of mental development, and to the imposing of tasks that for part of the pupils in the grade are very easy, while for others they are unwarrantably difficult.

In recent years it has been possible to determine the mental age of any given child quickly and with a good degree of accuracy by application of what are called the Binet-Simon tests. To supply a foundation for such a determination, the French psychologists Binet and Simon made elaborate analyses of the mentality of large numbers of children.

These experiments have furnished a basis for comparison which is accepted as having a wide range of applicability.

According to the scale, it is determined that the



Determining the mental age of a child by the application of the Binet-Simon and Sequin tests

average or normal mind at a given age can make certain observations and deduce certain conclusions which may be regarded as typical of a particular period of life.

Thus at a certain age a child becomes for the first time able to trace the outline of a simple figure with a pencil; at a certain age it has learned to recognize the primary colors by name; at a certain age it can repeat a given number of words or figures consecutively on hearing them once, and so on.

By a series of such practical tests, becoming more elaborate of course with the advancing age of the child, a system is provided through which it becomes possible to gauge the mental age of any individual child irrespective of the child's actual age in years. And when such tests are applied, it soon becomes evident that the school classes, as ordinarily graded, contain a great many very serious misfits.

There are physically well-developed boys and girls of sixteen whose mental age is only ten or eleven; just as, contrariwise, there are children of ten or eleven whose minds have advanced to the sixteen-year-grade of perceiving and thinking capacity. Of course, every teacher has been vaguely aware of such discrepancies, but hitherto there has been no definite way of testing them with accuracy; inasmuch as a misfit pupil might by excessive diligence keep his grade and struggle through his examinations without realization on the part of the pupil himself or of teacher or par-

ents that the effort required to produce this result was an abnormal one.

The advantages both for the normal and abnormal child, in having tests applied that would produce a more scientific grading are patent to every educator. Hence the eagerness with which the new tests have been taken up. As usual in such cases enthusiasm has sometimes outrun strict knowledge, and the specialists are now coming to point out certain limitations of the Binet-Simon tests, and in particular to urge that these tests cannot advantageously be applied by amateur psychologists; but the value of the tests as properly applied by skilled investigators is freely and generally admitted.

At the Buffalo Congress on School Hygiene, an elaborate conference was devoted to this aspect of education.

Dr. H. H. Goddard has made elaborate application of the Binet-Simon tests to the children under his care at the Vineland Training School for Defectives. He also tested recently a large number of the school children of New York City, and his studies here revealed an astonishing number of defectives whose inherent mental disabilities had not previously been fully recognized.

Dr. Goddard thinks that the Binet-Simon tests deserve a place beside Darwin's exposition of evolution and Mendel's laws of heredity.

The time is probably not distant when every wise parent will apply similar tests to his own children, and will be governed in considerable

measure in directing the education and in the selection of vocations for his offspring by what the tests reveal. If your child fails to get on well at school, or manifests any peculiar traits that cause you solicitude, it will be well for you to have the Binet-Simon tests applied by a competent examiner.

Nature Versus Nurture

It is eminently desirable that you should study the hereditary tendencies of your children, and note at the earliest possible moment what particular strains of ancestral traits seem to be dominant in each one, for, according to the newest teachings of heredity, members of the same fraternity may differ very radically in this regard.

It will be obvious that children inheriting different physical and mental traits may require quite different treatment.

In particular, if the study of your family history shows the tendency to any given disease,—say tuberculosis,—it will be the part of elemental wisdom to bear this fact in mind in caring for your children. But after full allowance has been made for all hereditary tendencies, it remains true that a tremendous, and in many cases even a dominating, influence may be exerted by environment. Take, as an extreme illustration, the case of a child who is born with the utmost degree of susceptibility to tuberculosis. It is a truism to say that notwithstanding such susceptibility the child would never become tubercular were it possible to

shut it away absolutely from the invasion of the tubercle bacillus.

And the same thing holds true, with equal obviousness, regarding each and every germ disease; that is to say, regarding practically all the maladies that chiefly menace the health and life of the infant and growing child.

Such an illustration vividly presents the case of environment as against heredity.

A similar application might be made, although it could not be so tangibly illustrated, with regard to the mental and moral traits of the child. Here also the influence of the surroundings may be sufficient to determine in very large measure, whether a given child shall grow up a normal member of society or whether it shall become a perverted criminal or an insane dependent.

But in practical life it is not possible to shelter the susceptible child absolutely from the menace of unwholesome surroundings. So it is necessary to fortify the individual constitution by hardening it and rendering it more or less immune to the effects of adverse conditions. We are learning more and more as the study of germ disease becomes more profound, that safety against these diseases depends very largely upon the development in the organism of antidotes to the bacterial poisons. In specific cases, such as smallpox and typhoid fever, we may aid nature by using preventive vaccines. But there are numerous bacterial diseases against which as yet no system of preventive innoculation has been devised.

The way to fight these diseases is to bring the body to the highest possible plane of general health.

It is noted in every epidemic of a virulent disease that there are individuals who are not susceptible. Generally speaking, these are the persons who have the largest measure of what, for want of a more precise term, is commonly spoken of as vitality. As a general observation, the weakly and ill-nourished children in the community succumb to contagious diseases where the strong, well-nourished escape.

It is the part of elemental wisdom, then, to study the physical traits of your children and to adopt, under medical supervision, such a regimen of diet and general hygiene as will give each child the fullest measure of robustness of constitution that its hereditary limitations permit.

It is in following out this idea on a large scale that the modern hygienist advocates life in the open air for children in general, and in particular for those who lack inherited robustness of constitution.

Playground Versus Schoolroom

We now know that the weakly child should be kept on the playground rather than in the schoolroom, even at the expense of retardation of its book education.

A sickly child that has been kept out of school altogether up to the age of seven or eight will generally be farther advanced in its studies at the

age of twelve than it could possibly have been had its physical health in earlier childhood been sacrificed to the parental solicitude for its book training. For the child with susceptible lungs—and, indeed, for children in general—that wonderful modern invention, the open air school, is a positive boon.

As supplementing the out-of-door life for the weakly child it is desirable to practise a systematic hardening of the constitution with the aid of cool baths. These should be used with judgment, of course. To subject the child to a cool bath from which it does not react healthfully would be detrimental. But by beginning early and tempering the bath to the needs of the individual, gradually using cooler water as the child becomes accustomed to it, it is possible to develop a hardiness of constitution, and powers of resistance to changes of temperature, which will stand the individual in good stead.

To be susceptible to all changes of temperature, and thus rendered perennially unhappy about the weather over which we have no control, is to carry a tangible handicap in the business of everyday life.

The judicious prescription of open air life and cool baths for the growing child may very largely give it immunity against this influence.

A child thus hardened will be but little susceptible to "taking cold"; and it will have corresponding power of resistance against the germs of the more virulent maladies.

The daily experience of the child that mingles

much with other children and participates in the rough-and-ready games of childhood, will result not only in the development of physical robustness, but also in a considerable measure of what Dr. Barker very aptly describes as psychic hardening. Dr. Barker suggests that one reason why women are more prone in later life to nervousness than men may lie in the lesser opportunity that girls have for bodily and psychic hardening in the games which they play and the life which they lead as children.

He particularly cautions that care should be taken with young girls who show any tendency to nervousness to see that not too much concession is made to their likes and dislikes, since for such children nothing could be more harmful than the gratification of caprice.

"Especially when a child shows a tendency to be nauseated by certain smells and tastes and to complain of noises and a sensitiveness to bright light," he urges, "the family physician should be consulted, and, provided no actual disease of the sense organs or brain is responsible, the processes of psychic hardening should at once be begun." This process includes keeping the infant in a normal routine despite any emotional outbreaks; in repression of outbursts of temper; and in convincing the child that it can get things by controlling itself rather than by emotional explosions.

And as to all this, the home training may best be supplemented by the wholesome influence of

association with other children. In the wonderful commonwealth of the playground, the emotional outbursts of the individual are made to seem ridiculous, egoistic desires are subordinated to the wishes of the many, and lessons in self-control are inculcated that will be of utmost importance in after life.

The parent who adopts the coddling process of keeping his child away from the " rough " associations of the playground does that child an irretrievable injury.

Moral Training

As further stabilizing the developing mind and giving it a just estimate of its own relations to the environment, it is desirable, particularly in the case of the nervous child, to guard against meeting its complaints with an exhibition of undue sympathy. Undue egoism is the perennial fault of the unstable mind, and this may begin to show itself at a very early period.

The desire to attract attention at all hazards is a symptom which should be regarded by the parent with out and out solicitude.

A typical illustration of this desire carried to an extreme is shown in the record of a girl who is now the inmate of a reformatory institution. The case is recorded by Miss Winifred Hathaway, in a Bulletin of the Eugenics Record Office. " From childhood this girl would do anything to attract attention to herself. For instance, when

' Jack the Snipper ' was cutting the hair of girls in the streets of Boston, the patient caused a sensation by cutting off her own hair. She hid it and invented a thrilling story of her encounter with the vandal, was delighted when brought to court, and confessed only when confronted with hair which had been found.''

Not many children go quite so far as this, to be sure, but exhibitions of the same general character and import are matters of everyday experience.

The wise parent will treat such craving after sympathy and attention as evidence of mental and moral instability. To cater to this craving is to stimulate development in the wrong direction. In the case of the girl just referred to, the failure to repress this abnormal tendency permitted the development of a character that was finally diagnosed as '' deficient in any moral sense, incapable of acquiring it, and requiring permanent custodial care.'' The girl had so far degenerated at the age of nineteen that the Binet-Simon test gave her mental age at 11.4 years. Yet she had been fairly good at her school studies at an earlier age, reaching the eighth grade with no particular difficulty.

The traits which in the young girl were characterized as '' wilfulness and quick temper,'' and the egoism that manifested itself in the childish trick of hair-cutting, had been permitted to develop and to reach a culmination in immorality and mental decadence.

Such a case conveys a warning which should not be blinked at by the parent of any nervous child whose craving for sympathy, undue sensitiveness, and tendency to take offense at fancied slights give evidence of its unhealthy egoism. Of course, the hungry mind should not be embittered by the absence of judiciously worded and sympathetic approval on occasion, but wholesome restraint should be inculcated by the avoidance of injudicious and indiscriminate praise; and every effort should be made to restrain the eccentricities of such a child and to mold it toward the normal, instead of fostering its peculiarities and taking pride in its abnormalities as parents are prone to do.

The Need of Sex Education

In recent years we have heard on all sides reference to "sex hygiene" as a topic meriting the careful attention of the educator. Until very recently the subject was quite unheard of in this connection. The reason for the change in the public attitude is, presumably, that we have not progressed very well under the hitherto prevailing method of reticence.

The puritannical spirit of our forefathers made the subject now implied by "sex hygiene" taboo in all general discussions. But the undiscussed subjects were in no wise subordinated, and the spread of what is euphemistically described as "white slavery," and of venereal diseases, with their patent evils, served finally to convince a

large number of educators that we were not on the right track. At Mannheim, in Germany, in May, 1907, there was held a conference of sex hygiene at which a discussion of the teaching of sex in schools and colleges was participated in by the most distinguished educators and physicians in Germany.

There was a general concensus of opinion, according to the report of Dr. Prince A. Morrow, that sex should be taught in the secondary school classes and the colleges and universities, and by some it was urged that it should be taught in the elementary schools.

" All agreed that while instruction in the origin of life should be given in the home and at an early age, the majority of parents were not qualified to give it, and that the duty therefore devolved upon teachers, and should be an integral part of the course of study in all normal schools.

" In most of the states of Germany, courses of sex pedagogy for advanced high school students have been established. As these students are discharged from school, they are enlightened by medical lectures on the nature and peril of venereal diseases. There have also been established lectures for parents in order to enable them to deal intelligently with the sexual problem in the education of their children. Somewhat similar work is being done in France, and the teaching of sex has been made mandatory in the Lycées by the Minister of Public Instruction.

" In this country, a number of biological teach-

ers have, of their own initiative, inaugurated the biological teaching of sex in high schools and colleges. At the October meeting of the American Society of Sanitary and Moral Prophylaxis, papers were read by President Hall of Clark University and Professor Bigelow of Teachers College, Columbia University, and discussed by leading members of the Biological Teachers' Association. The opinion was freely expressed that sex instruction forms an absolutely essential part of a rational education, and that the benefits to be derived from the biological teaching of sex were so great that all opposition thereto was bound to disappear.

"The necessity of such teaching was held to be too evident to be discussed. The question now was one of matter and methods—the facts to be taught, the study of specific methods, the adaptation to the age and mentality of the youth, and the training of teachers in normal schools for this important work."

The growth of the movement in this country is further evidenced by the fact that the National Federation for Sex Hygiene has for honorary president that most distinguished of American educators, President-Emeritus Charles W. Eliot of Harvard. Under the auspices of this federation, a committee comprising Professor Thomas M. Balliet, Dean of the New York School of Pedagogy, Professor Maurice A. Bigelow of Teachers College, Columbia University, and the late Dr. Prince A. Morrow, formulated a plan for sex edu-

cation, and secured the opinions of a large number of prominent educators and medical men.

The report of these investigators was presented before the sub-section on sex hygiene in the Fifteenth International Congress on Hygiene and Demography, held in Washington, in 1912, and was subsequently issued as a pamphlet for general distribution.

Thirteen propositions, covering the essential aspects of sex education were submitted to the educators and medical men whose opinions were sought, and the almost unanimous response left no possible doubt as to the present tenor of opinion as to the " need of special instruction of young people in the scientific principles of sex."

As to that fundamental proposition, indeed, there were 91 responses in the affirmative, as against no negatives and only 5 expressions of doubt.

In expressing his own belief in the need of such instruction, the Rev. Josiah Strong, President of the American Institute of Special Service, made the following statement: " Inquiries made more than fifteen years ago, in New England, Minnesota, California, and in thirty cities of Pennsylvania, all revealed a shocking condition among children, indicating great need of sex instruction; and the answer to 2,000 letters of inquiry sent eighteen months ago to school superintendents and principals in all the States of the Union confirmed the judgment."

Professor Peter Frandsen, of the University

of Nevada, described the need of such instruction as fourfold: " (a) Hygienic and eugenic—better sex health and better progeny; (b) The control of venereal diseases; (c) To save young people from needless mental disturbances over normal sexual phenomena, and to save them from the impositions of quackery; (d) To change the attitude from the present one of total avoidance, or a subject fit only for lewd conversation, to one of serious respect."

Sex Education Must Begin Early

Dr. Balliet's report expressly recognizes the fact that the " less children and youth think of sex, and the later they mature sexually, the better for them both physiologically and ethically; and that premature development of the sex consciousness and the sex feelings is harmful."

But it also recognizes that the subject cannot be banished from the world of the child, and that there is peculiar danger that the child will receive sex information from impure sources. It emphasizes the need of very early instruction. Even as regards social disease, it is declared that " some direction of individuals is sadly needed by many children in the two or three pre-adolescent years; and it is to be hoped that every school will finally have one or more competent persons (principal, nurse, doctor, or teacher) able to deal effectively with the individuals needing help."

President Arthur H. Wilde, of the University of Arizona, declares that " in all towns and cities

many of the children, even in the best families, have started down even before the age of ten. A very necessary activity is the study of the children's home surroundings; and it is also necessary to convince parents that children, at an early age, may have wrong notions and incipient vices." And as to smaller centres of population, Principal G. L. Bowman, of the Training School for Teachers, at Menomonie, Wisconsin, affirms that much damage is done to boys at a very early age by what he describes as "the tramp woman."

But it is further urged that the child needs attention not merely during adolescent and pre-adolescent years, but even during infancy. In point of fact it is true that in very many cases the improper sex education which is to shape the entire moral life of the individual is inadvertently gained in infancy. Every experienced specialist could cite cases of ineradicable perversion, directly traceable to influences to which the child was subject when not more than three or four years of age.

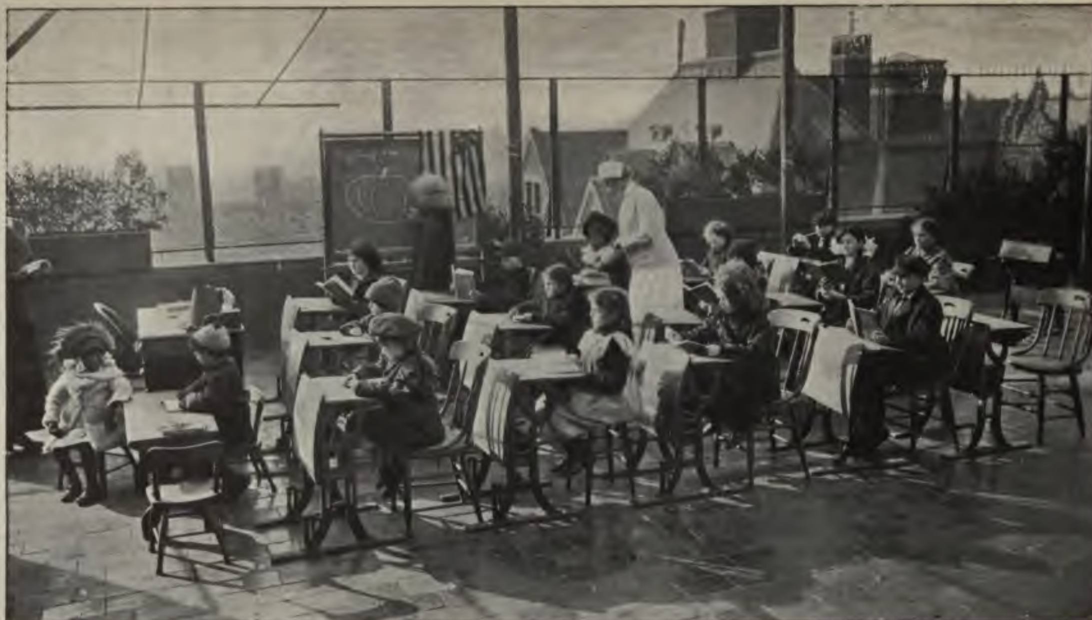
Hence the pertinency of the admonition given by Dr. Balliet and his colleagues with reference to the care of the child during this earliest period.

"The period from one to six," says the report, "is the period preceding admission to school, and is, therefore, the only period during which the care of the child falls chiefly upon the mother—the kindergarten at present reaching only a small proportion of children. It is, therefore, important that in lectures on sex education given to mothers, special emphasis be laid upon this period,

and that proper instruction be given as to the care of the child's body. The danger to the child of placing it in the care of an immature or injudicious nurse should be pointed out. Instruction should be given as to how the child's questions relating to the origin of human life may best be answered. This is the only sex instruction a child needs during this first period. In addition to this, watchfulness over the child's habits, and protection from untoward influences constitute the mother's chief duty."

But this " watchfulness over the child's habits," implies far more than most parents realize. As Dr. Morrow urges, the foundations of what may be called the sexual character are laid in early youth; and " the ideals and principles instilled in this formative period are apt to determine the attitude toward sex and the sex relation throughout life."

" Many parents," says Dr. Morrow, " are silent because they fear to soil the ' crystal purity of the youthful mind ' with a thought or suggestion of anything so shameful as sex. If ignorance were a preservative of innocence, if their silence shielded youth from sexual errors, it might be justified. But there is nothing more fatuous than the belief that they succeed. The objection urged by some that sex education would stimulate an unhealthy curiosity, and focus the imagination upon sexual matters, is scarcely more valid. Curiosity about the origin of life and sex already exists; it is implanted by nature. If it is not satisfied from pure sources it will be fed from impure and tainted



The opportunities for out-door life for children have now been extended to school hours in some places

sources. It must be the pure wholesome education of the home or the corrupt teaching of the streets; there has been no alternative."

Idealizing the Sex-Relation

It is deplorable that the majority of parents are but poorly qualified to give their children specific instruction of the right kind at the later periods of development.

It is urged that, to meet this defect, systematic courses of lectures for parents should be provided at public expense. President H. A. Garfield, of Williams College, suggests that following the lectures to parents only, it may be well to arrange a course of lectures to parents accompanied by their children. This, he declares, would tend to establish mutual confidence between parent and child.

Until this excellent advice can be generally put into effect, it remains the duty of the professional educators to supply the instruction which the average home cannot give. The admirable suggestions as to details of such instruction, which Dr. Balliet and his colleagues put forward with the approval of almost one hundred of the leading educators of America, need not be elaborated here. Suffice it that great stress is laid on the value of biological training through which the fundamental facts of development are presented in their broadest aspects.

But it is urged that the purely scientific instruc-

tion must be reinforced by ethical instruction, both direct and indirect, with due regard to the maturity of those taught. "Appeals to the sense of personal self-respect and purity and to the instinct of chivalry can be effectively made in the earliest years of adolescence, and even before. With relatively mature students, the vast sociological bearings of the subject, with their ethical implications, can be effectively utilized.

"Among the means of indirect ethical instruction for this purpose, the most effective is good literature. It is of immense consequence that during the adolescent years the pupils' minds be saturated with the great masterpieces, both in poetry and prose, which deal with romantic love in its purest forms. Thought of sex emotion must at this time be spiritualized and placed on the highest plane, and good literature is the most effective means to this end which is available in the public schools. Any kind of sex education which ignores the education of the emotions is seriously defective. Deep intellectual interests, enthusiasm in art, or ardent devotion to some worthy, practical cause, absorb the mind and furnish wholesome avenues for the expression of the emotions.

"Few conditions are so dangerous at this period as idleness, whether physical or mental, and an absence of interest in things which appeal to the higher altruistic instincts."

Yet another aspect of sex education is recognized in this declaration: "The value of physical

exercise, especially in the form of play and athletic sport, in its bearing on the control of the sex instinct, is so generally recognized that it needs no special emphasis here.''

To parents who, under spell of the old ideas, are disposed to question the advisability of attempting to break down the barriers of reticence that have hitherto surrounded this subject, the concluding paragraph of Dean Balliet's report may be especially commended:

'' In conclusion, your Committee would emphasize the necessity of good judgment and tact in introducing sex instruction into schools. It should not be introduced prematurely, but only so fast as teachers can be found or trained who are competent to give it, and so fast as public sentiment will support it. On the other hand, undue weight must not be given to the difficulties attending such instruction even under present conditions, inasmuch as even occasional mistakes will do far less harm than allowing children to continue to gain this knowledge, as many of them now do, from impure sources—receiving a pernicious first impression which induces in them an attitude of mind toward the subject that makes it extremely difficult later to give them the best instruction. In not a few such cases sound teaching is practically fruitless.''

And this may be supplemented by an expression made by Professor Bigelow, in another connection, where he says:

'' Now unless we can devise some way to counteract the prevailing narrow, vulgar, disre-

spectful, and irreverent attitude towards all aspects of sex and reproduction; unless we can make people see sexual processes in all their normal aspects as noble, beautiful, and splendid steps in the great plan of nature; unless we can substitute a philosophical and æsthetic view of sex relationship for the time-worn interpretation of everything sexual as inherently vulgar, base, ignoble, and demanding asceticism for those who would reach the highest spiritual development; unless we can begin to make these changes in the prevailing attitude towards sex and reproduction, we cannot make any decided advance in the attempt to help solve sex problems by special instruction."

"I cannot believe," Professor Bigelow concludes, "that sex education is one of the long line of educational fads which quickly pass their day, for no other phase of education so closely touches life. History and geography and even a large part of the three R's may be of little use in the lives of numerous people, but sex education deals with problems which the normal human life cannot possibly avoid and which each individual must be prepared to solve for himself. Therefore, we may confidently assert that scientific instruction concerning the most important aspects of sex processes and relationships has come to stay, and that it will soon be recognized as an absolutely necessary part of a rational and efficient scheme for the education of young people."

IX

Adding Years to Your Life

DO you know how old you are?

The question sounds absurd but is not. Of course you know when you were born; but are you sure you know how fast you have lived? Age is not measured solely by birthdays. It is far more surely measured by the state of your arteries. These may be elastic and resilient, in which case you are young, whatever your years; or they may be hard and brittle, in which case you are old, however short the time since you were born.

You may in reality be thirty-five or forty years *old,* while your neighbor is properly to be spoken of as seventy or seventy-five years *young.*

The difference is that your neighbor has learned the secret of right living, whereas you, if old at forty, are probably poisoning yourself daily with the food that you eat.

Perhaps you are not even aware that common foods may become poisonous to you under certain conditions. Quite possibly you have no clear notion as to the precise quantities of meat and other foods that your system requires day by day. Yet, if you eat too much nitrogenous food, the bad effects will make themselves felt on your arteries,

and you will age in reality by two or three years with each successive birthday.

Proteid (meat) poisoning makes brittle arteries; and a man with brittle arteries has the sword of Damocles hanging with perpetual menace over his head.

Hundreds of thousands of people are thus menaced, as the death rolls from "apoplexy," "heart failure," "paralysis," and sundry diseases of liver and kidneys prove day by day.

Do you know whether you are thus menaced? If not, it is worth your while to find out.

The alarming prevalence of this condition of arterial degeneration gives peculiar importance to a report read at a meeting of the Paris Academy of Medicine last May by Professor Letulle. The report concerns the remarkable work done there in recent months by Dr. Moutier in the way of treatment of diseases of the arterial system with the high-frequency electric current. It was reported that Dr. Moutier has succeeded in a large number of cases in restoring diseased arteries to a normal condition, thus giving a normal blood supply to the tissues.

Every organ of the body may suffer from diseased conditions of the arteries; which explains the report that the new treatment has been applied to the amelioration of a multitude of disorders affecting not merely the heart and vascular mechanism in general but various abdominal organs, including the liver and the kidneys.

It is highly interesting to add that almost simul-

taneously the report comes from Berlin that Dr. Saubermann has accomplished similar results by treating diseased arteries with radium.

These discoveries deal with a subject of profound importance. In 1910 more than 100,000 persons died in the United States from diseases of the circulatory apparatus. The aggregate death roll of typhoid fever, malaria, smallpox, measles, scarlet fever, whooping-cough, diphtheria, influenza, and several minor bacterial diseases was only 59,000.

Thus the diseases of the heart and blood vessels were directly responsible for almost twice as many deaths as were due to an entire coterie of much-dreaded contagious diseases.

We hear on all sides an outcry against the great white plague, and the whole world is eagerly awaiting the discovery of a cure for cancer. Yet tuberculosis causes the death of only 160 persons per 100,000 of the population, and cancer and other malignant tumors claim only 76, as against 185 who fall victim to diseases of the circulatory system.

Moreover, there are many degenerative maladies affecting other vital organs that are inaugurated by or dependent upon disturbances of the blood supply; and these degenerative diseases affecting the heart, blood vessels, kidneys, and other vital organs are very actively on the increase. It is computed that the death-rate from this class of diseases per 100,000 of the population was 190 in 1880, that it advanced to 243 in 1890,

to 314 in 1900, and to 387 in 1908; thus more than doubling in the course of a single generation.

This explains why the life insurance examiner nowadays pays such exceptional attention to the state of your heart and kidneys. He knows that there is more than an even chance that you are not altogether normal as regards these vitally important organs.

It appears, then, that while medical science has been combating the microbes and decreasing infant mortality, it has tended to overlook the average middle-aged person. He is dying in larger and larger numbers of degenerative diseases. A recent report of the Department of Health shows that the "expectancy" of life after forty has diminished by fifteen years for males and by eighteen for females within the present generation. Your father and mother, at forty, had a far better prospect of living to a green old age than you have to-day. And the alarming change is closely connected with errors of diet that lead to degenerative changes of the arteries; changes which have hitherto been considered incurable, but which, according to the reports from Paris and Berlin, may now be brought within the scope of remedial treatment.

But while great interest and importance thus attach to the possible restoration to the normal of arteries that have become diseased, it should go without saying, in this age of preventive medicine, that a still greater importance attaches to the question: How can we prevent the arteries from

becoming diseased? Here as elsewhere prevention is far better than cure.

And it fortunately happens that these maladies are pre-eminently preventable.

In the main they are brought on by habits of life that might readily be changed. It is scarcely an exaggeration to say that the great bulk of the 100,000 people who die prematurely each year in this country of diseases of the vascular system have been so directly responsible for shortening their own lives that they might not inappropriately be described as involuntary suicides.

It should be of interest to you and me to inquire whether we, individually, are likely to add our names to the list.

Poisons in Our Daily Meat

One of the most striking conclusions to which recent investigators have come is that a very large proportion of people who have reached middle life have acquired habits of eating that are directly injurious, and that subject their systems to a slow poisoning that in effect hastens old age and ultimately brings death itself.

There is nothing new in the statement that most people eat too much. But the new investigators go beyond this and point out the precise kinds of food that produce particular types of injury. They tell us that a great number of persons who have passed middle life have accustomed themselves to a diet that includes an excess of proteids,—that is

to say, of foods that contain nitrogen, of which prominent examples are eggs and all kinds of meats.

"Protein," says Dr. L. F. Bishop of New York, "is very important in building up the tissues, strengthening the muscles, and stimulating the activity of the brain and the emotions. It is the food that produces great leaders and brain workers, but it is also a food that in the present day is terminating prematurely some of the best lives in the nation."

The specific explanation given by Dr. Bishop of this rather alarming statement is based on a long series of observations in which laboratory work has joined hands with clinical experience. This work has to do with a condition of the organism which the specialist terms "anaphylaxis." Stated untechnically, this means a curious susceptibility to a particular food or medicine. Such so-called idiosyncrasies have been known in a general way from the earliest times. It is traditional that "what is one man's food is another's poison." But the scientific investigation of the matter is altogether modern. A pioneer in the field is Professor Victor C. Vaughan, who tells in a recent number of *The American Journal of Medical Science* of some curious instances in which ordinary foods may become poisons to particular individuals.

For example, an individual may become susceptible to the poisonous properties of the protein of egg or of fish, or of beef or mutton. The in-

dividual in whose system this undue sensitiveness has developed may be quite unconscious of his infirmity. Indeed, the food that particularly poisons him may be one of which he is especially fond. So he continues to take it in large quantities and is steadily and persistently poisoned. The effects are not immediately obvious in a marked degree, but the cumulative result is finally apparent in the degeneration of many tissues, leading ultimately to a marked disturbance of function of such all essential organs as the heart and vascular system, the liver, and the kidneys.

It is this that Dr. Bishop has in mind when he assures us that slow poisoning by protein accounts for a very large number of deaths. He believes that the typical malady of middle life known as arterio-scelerosis, or hardening of the arteries, is due to systematic poisoning from the habitual ingestion of foods to which the particular individual has become unduly sensitized. In his judgment there are hundreds of thousands of people, mostly above the age of forty, who are daily jeopardizing their health and inducing premature senility with ultimate shortening of life.

These facts should be known to and pondered by every individual who has reached middle life. But how, practically speaking, may you and I know whether we are poisoning ourselves? In order to answer that question we must get a clear idea of the conditions under which that strangest of mechanisms, our own body, operates in health and in disease.

The Animal Machine

It is only in comparatively recent times that we have come to understand that the bodily mechanism is a machine subject to laws that apply to all types of machinery.

It is a mechanism that cannot work without exhausting or transforming energy. Even when the body is at rest there is still constant loss of energy through the giving off of heat. It has become customary to think of the animal machine as a heat engine and to measure its activities in terms of so-called calories; a calory being the amount of heat required to raise a kilogram of water (a little over a quart) by one degree Centigrade. The aggregate amount of energy utilized by the human body in a day may vary, according to the size of the individual and degree of activity, from 2,000 to 8,000 or even 10,000 calories.

The materials oxidized or burned in the body to generate this energy are supplied by the food.

Did you ever stop to consider what a marvel it is that your body is able to conserve heat when heat is needed and eliminate an over-supply, using always just the right amount of fuel and keeping in perfect running order if given half a chance?

You are out in the open on a winter day, drawing deep breaths of air at a temperature, say, 10 degrees below zero. Every inhalation draws frigid air into your lungs, and each exhalation carries from your body a modicum of heat. But your bodily heat-engine burns fuel with such nice ad-

justment to your needs that your temperature remains hour after hour at 98.4 degrees Fahrenheit.

Six months later you are walking under a tropic sun, the thermometer registers perhaps 90 degrees in the shade, and the air you breathe seems to come from a furnace. But your bodily temperature now as before is 98.4 Fahrenheit.

If you suddenly jump about or run briskly, you in effect put a bellows to the bodily furnace. Your heart beats faster; your breath comes in gasps; and judging by your own feelings you have made your blood almost boil. But meantime the blood vessels lying at the surface of your body have relaxed, and the blood thus brought to the surface radiates heat into the surrounding space, and thus cools your body as a whole in spite of your feeling of warmth; and this cooling is greatly aided by the perspiratory glands with which your skin is thickly provided, which now ooze water, exuded from the blood, which in evaporating takes up a relatively enormous amount of heat.

The skin thus performs for the body the service done by the water-jacket in an automobile engine.

But it is obviously essential for the proper working of this wonderful heat regulator that the blood vessels should be elastic and resilient, responsive to the mandates of the nervous mechanism. Nor can we expect ideal conditions if the body is constantly called upon to consume a needless supply of fuel and thus to generate an undue quantity of heat. Under such circumstances, the excretory channels become clogged with waste products, just

as the carburetor and cylinder of a gasoline motor become clogged if too much gas is supplied or an improper admixture of gas and air.

You are well aware that your automobile engine will not work without proper fuel. Neither will your bodily engine.

The automobile mechanism quickly wears out and becomes ineffective if the conditions essential to its well-being are not maintained. So does the bodily mechanism.

If you are wise you will take at least as good care of your bodily machine as you do of your gasoline motor. You can buy another automobile if your present one wears out; but you have the use of only one body in this life, and no opportunity will ever be given you "to do better next time."

Fuel for the Bodily Engine

Let us ask, then, a little more specifically, just how it may be known whether you, individually, are supplying your bodily machine with the right kind and right quantities of fuel.

The chemists tell us that notwithstanding the great variety of foodstuffs, they may all be classified under three headings. Foods are either proteins, or fats, or carbohydrates. Fats and carbohydrates consist of carbon, hydrogen, and oxygen; protein contains the same elements with the addition of nitrogen.

The familiar carbohydrates are starches and sugars in their various combinations.

The proteins are supplied by meats of all kinds, and by milk, cheese, and eggs. There is also protein in bread, and a relatively high percentage in leguminous vegetables such as beans and peas.

All three classes of food products supply fuel to be oxidized or burned in the system. But there is a very radical additional function subserved by the proteids, or nitrogenous foods. These supply nitrogen to take the place of that which is constantly set free in the action of muscular tissue and eliminated from the body. The bodily machine immediately begins to run down if the nitrogen-bearing proteids are withheld or the supply is insufficient in quantity, and no amount of fats or of carbohydrates can make up the deficiency.

But on the other hand, as we have seen, the same proteins if supplied in excess or of improper quality may be the undoing of the bodily mechanism. So here we are placed between the devil of too little nitrogen and the deep sea of too much. We cannot live without the nitrogen, and if we are not careful we shall find that we cannot live with it. Obviously, the situation demands a compromise.

What Meat Is Your Poison?

The practical solution is found in the facts that (1) we know how much proteid matter the organism requires in a day, and (2) we know that certain classes of proteids are under suspicion as producers of degenerative changes of the blood vessels and vital organs. Your individual task,

then, is to make sure that your dietary includes proteids in adequate quantity (but not greatly in excess) and that deleterious proteids are excluded.

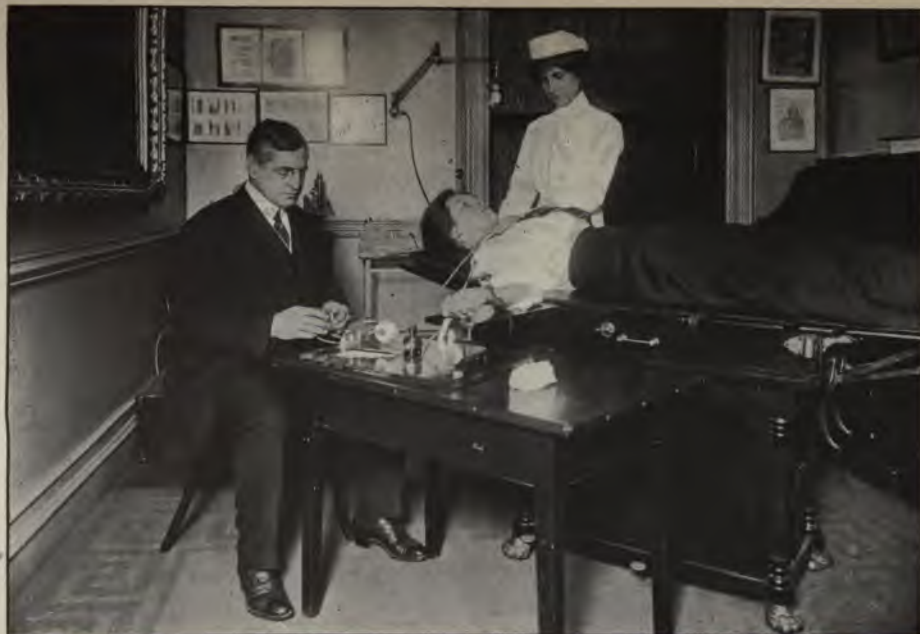
You perhaps suffer now and again from headaches and neuralgias. You may be rheumatic or gouty. You are subject to attacks of biliousness; are easily fatigued; lack energy and initiation of mind and body; find yourself short of breath on walking briskly or on going upstairs. At times your heart palpitates unduly.

These are all symptoms that suggest disturbed assimilation.

The first question to ask yourself is this: Is there any food that I am accustomed to take habitually that is poisonous to me? It is quite possible, according to the newest theories above outlined, that your regular diet may include something that to you individually is toxic, yet which is altogether wholesome to people in general and even to members of your own family.

The obvious way to test the matter, if you have any doubt at all on the subject, is to cut out one or more of these questionable foods from your dietary for a given period, and note the results. The proteids that are most under suspicion are those contained in the animal albumens—meats of all kinds, including fish, and eggs—and in such leguminous vegetables as peas and beans; and the uric-acid forming constituents of tea and coffee. In making a radical test, all these should be avoided.

It is unquestionable, however, that you may be



Dr. Bishop using the sphygmograph to ascertain the quality of the heart-beats

suffering from a slow poisoning due to deleterious food without experiencing any symptoms that you associate directly with your diet. Your arteries may be gradually hardening week by week, without producing any sensation that arouses your suspicion. About the only way to put the matter to a crucial test is to go to your physician and have him measure your blood pressure. It is now recognized that increased blood pressure is one of the earliest symptoms of proteid poisoning.

The physician is provided with several appliances by which the pressure may be tested, and is able to offer timely warning to many a middle-aged person who supposed himself to be in fairly good health, or who as yet has only vague premonitions of his malady.

What the Blood Pressure Shows

Altered blood pressure may be due to the condition of the heart itself or to changed resiliency of the arteries and capillaries through which the blood courses.

But recent studies strongly suggest that the initial condition in a great number of cases—perhaps in all cases—is an abnormality of the blood itself. Recent experiments tend to confirm the claims of the London specialist, Dr. Alexander Haig, that where high blood pressure is found, the blood is always unduly viscous and tends to become clogged at the minute apertures of the capillaries. The famous English physician, Sir Lauder

Brunton, recently reported a case in which there was such viscosity that scarcely any blood flowed even when a vein was opened.

The thickening of the blood which thus disturbs the circulation, and which is premonitory of disaster, may be due to the ingestion of unwholesome foods or merely to the ingestion of an excessive quantity of wholesome ones. Thousands of men and women of sedentary habits have accustomed themselves to a daily regimen, including some such combination of proteids as the following: At breakfast, two eggs and a slice or two of bacon; at lunch, a cup of bouillon, mutton chops or a slice of beef, green peas, and a portion of cheese; at dinner, a long series of proteids, including oysters or clams, soup, fish, fowl, and a red meat.

Such a dietary is utterly abnormal and must inevitably lead to disaster.

No one but a laboring man or an athlete in full training could with impunity eat regularly even small portions of such a variety of proteids. And no wisely trained athlete would think of undertaking such a feat. The most powerful athletes that I have personally examined eat meat only once a day, and a good many of them habitually take but two meals, breakfast comprising a roll and one egg or at most two, and dinner having for its chief proteid never more than a single kind of meat, and a moderate portion of that.

Such is the custom, for example, of George Bothner, perhaps the most remarkable athlete of our generation, who at 46 is boyish in face and figure

and who, after holding the world championship for more than ten years, is still invincible to any wrestler of his own weight.

Eating to Live

If your habits are sedentary, you obviously require less food than the athlete in training.

So it is more than likely that you eat not merely more protein but a great deal more food of every kind than is good for you. Not unlikely you consume daily twice as much food as your bodily machine can advantageously manage.

It is estimated that the man of average size who does little physical work requires not more than 50 to 60 grams of protein,—say about two ounces. We may gain a clear idea as to the amount of food that will provide this if we note the following estimate made by Dr. Bishop:

"Roughly speaking, but with sufficient accuracy for practical purposes," he says, "an average helping of meat contains 25 grams of protein, or to be more accurate, a cubic inch of beefsteak, beef, or fish contains 8 grams; an egg contains 8 grams, as does also a glass of milk. An ordinary helping of rice, potatoes, bread, or hominy contains about 4 grams of protein."

If, then, you were to take two eggs for breakfast, a glass of milk or a cup of bouillon at lunch, and a moderate helping of beef (say a piece of steak three inches long and one inch thick) at dinner, you have consumed a quantity of protein ade-

quate for the day's needs. And this without at all taking into consideration the protein contained in the bread, potatoes, rice, beans, peas, pudding, and soup that have rounded out your meals for that day.

Obviously you are a very moderate eater indeed if you do not ingest an excessive quantity of protein.

As to the total food supply measured in heat units, it is estimated that a man doing light work requires about sixteen calories of energy per pound of weight. A man weighing 170 pounds would therefore require about 2,500 calories. It is further computed that each ounce of proteid food supplies the body about 113 calories; and an ounce of carbohydrates also supplies 113 calories; and an ounce of fat about 255 calories. So a dietary comprising about 2½ ounces of proteids, and similar quantities of fats, and 14 ounces of carbohydrates would supply the daily needs of a man weighing 170 pounds.

This is less than 1¼ pounds of digestible matter. But of course there is an unavailable residue in most foods, so the actual quantity ingested would be considerably larger. An average day's supply of food for a man of 170 pounds might be apportioned as follows: To supply proteids, one egg, one pint of milk, one ounce of cheese, 6 ounces of meat (weighed before cooking); to supply fats, 2 ounces of butter (plus a certain amount of fats in the other articles of diet); to supply carbohydrates, 8 ounces of bread or equivalent bread

stuffs, 4 ounces each of potatoes, spinach, and tapioca, and 2 ounces of sugar. This represents an adequate fuel supply for a good-sized man of fairly active physical habits.

By experimenting a little with a pair of scales, you may quickly satisfy yourself as to whether or not your own dietary represents a reasonable fuel supply, or whether, as is probable, you are accustomed to take an amount of food a good deal in excess of your requirements. In the latter case, you will do well to recall that an excess of fuel must tend to clog the working of the bodily machine, bringing an undue strain upon the digestive and circulatory systems, thickening the blood, and overtaxing those all-important excretory organs, the kidneys.

Also you may quite likely have observed that a certain amount of the excess fuel tends to be stored away as adipose tissue, which becomes presently a serious encumbrance.

You must squarely face the question whether you will live to eat, pampering your appetite and risking the consequences, or whether you will eat to live, making a rational selection of food, and exercising a wise restraint as to the quantity ingested.

If you find it difficult to resist the allurements of the table, the classical experiment of Professor Chittenden of Yale may helpfully be recalled. In his personal experience, not only did rheumatism, "sick headache," and biliousness disappear when a carefully computed restricted diet was adhered

to, but " there was a greater appreciation of such food as was eaten, a keener appetite and more acute taste seemed to be developed, with a more thorough liking for simple foods."

So adherence to a rational dietary by no means implies the renunciation of all pleasure in eating.

Exercise the Sovereign Remedy

But however abstemious your diet, you cannot hope to keep your bodily machine in good working order unless you give some attention to the obverse side of the question of digestion and nutrition; that is to say, to the matter of bodily exercise. No discussion of longevity would be in any sense complete that left this out of consideration.

The case of the athlete who retains the resiliency and strength of youth at fifty or sixty years of age —to say nothing of a Weston who walks across the Continent at seventy-two—conveys a double lesson. Not only has such a person been rationally abstemious in his diet, but he has aided nature in maintaining a healthy condition of his bodily mechanism by giving all portions of that mechanism an opportunity to functionate normally. Which is only another way of saying that he has habitually exercised his muscles.

In so doing he has given tone to his heart and arteries by stimulating a normal circulation of the blood, and at the same time has facilitated the elimination of waste products.

Thus at sixty he may have an organism which,

judged by the condition of its vital tissues, is no nearer the final breakdown—no older, to use the conventional phrasing—than the system of the average gourmand of sedentary habits who, by count of birthdays, is twenty years younger.

Action of the muscles results in a more rapid metabolism of the tissues, accompanied by an increased burning of fuel. The contracting muscles directly promote the flow of the blood-stream in the veins and in the capillaries, thus tending to lower the arterial pressure. With bettered circulation, the perspiratory glands become active, and some of the products of combustion are eliminated by way of the skin. If your kidneys are not able to handle the waste products of the body with facility, this is highly important.

Of course games and sports that develop an interest are in every way better than mere perfunctory exercises.

Tennis, golf, baseball, hockey, and basket-ball are excellent, each in its own way. So are rowing, swimming, and riding. In default of anything better, brisk walking will serve a useful purpose; while mountain climbing for those whose hearts are in good order has many advantages.

The indoor games that afford the best all-round exercise are handball and court tennis. Wrestling, boxing, fencing, and bowling are all-round developers of muscle that partake also of the elements of recreation, and in a less degree the same thing is true of "punching the bag" and throwing the "medicine ball." Perhaps no single form of gym-

nasium sport combines so many advantages for persons past middle age as the game of handball. This gives vigorous exercise without inducing undue strain, and it brings into play every muscle in the body.

For persons in good condition, wrestling is an almost incomparable exercise; but it should only be undertaken as the sequel of a course of lighter training.

Whatever the form of exercise, it should be pursued with sufficient vigor to stimulate the heart's action, ensure deep breathing, and so increase the heat-producing activities of the tissues that the blood will be brought to the surface, the skin made to glow, and the perspiratory glands stimulated to free action. The latter effect may be further facilitated by a few minutes in a hot room or the equivalent, the "Turkish bath cabinet"; this to be followed with a shower bath, warm at first but toned gradually to the coldest degree from which the body will react.

The cold shower is doubly important because it not only closes the pores of the skin and obviates the danger of taking cold, but also acts as a general systemic tonic which has definite and lasting benefit.

If you have access to a gymnasium and will take a half-hour daily for such a routine of exercises, you may overcome the effects of improper diet, and prevent the deterioration of your heart and arteries with a fair degree of certainty.

But unfortunately our modern civilization has

not returned to that high standard of the Greeks and Romans in which the gymnasium, with all its facilities for healthful exercise, formed as invariable a part of the city development as the market place or the dwelling house itself. We shall be forced back to some such standard by and by. The time will come when every large office building and apartment house will have its gymnasium on the roof, to serve as the road to health for young and old of both sexes. But in the meantime, accepting conditions as they are, it is true that a large proportion of people have no opportunity to visit a gymnasium and must secure exercise in their own homes or not at all.

Fortunately it is possible to secure all the exercise that health requires without leaving one's own bedroom, and without the use of any paraphernalia whatever.

All that is necessary is to select a few intelligently devised exercises and to follow them up persistently for fifteen or twenty minutes every morning on first rising. If you will put yourself through a routine of ten or a dozen simple movements, aimed to bring into action the muscles which your ordinary occupation leaves undeveloped, you may secure many of the direct physical benefits of out-of-door games or gymnasium exercises without further encroachment on your time or business activities.

The muscles in question, in the case of ninety-nine persons in a hundred of sedentary habits, are those of the abdominal wall.

As you sit at your desk these muscles are relaxed, and they are brought but slightly into action by ordinary walking or by even a fairly vigorous action of the arms. So the muscles that should give strong support to the abdominal wall become a mere film of relaxed and ineffective tissues, padded with useless layers of fat. The all-important abdominal viscera not only lack normal support, but they are encroached upon and crowded out of place by masses of adipose tissue that subserve no useful function.

The person of distended waist line suffers from shortness of breath, not necessarily because his lungs or heart are affected, but because the adipose tissue crowds the liver and other viscera into the thorax, thus restricting the breathing space. But the deposit of excessive quantities of fat is in itself evidence of defective circulation of the blood; and unless the condition is corrected, there is a tendency to weaken the heart, further interfering with the circulation and facilitating thus the degenerative changes which lead to arterio-scelerosis with its all too familiar attendant evils.

But no one need suffer from such degenerated abdominal muscles, or from such accumulation of fat in the region of the waist, if he has the intelligence and the strength of mind to follow a systematic line of exercises aimed to keep the abdominal wall in a state of healthful efficiency; assuming always that at the same time he will practice reasonable self-restraint in eating.

Treating the Abdominal Muscles

Anyone can devise exercises that will bring the abdominal muscles into action, but unless you have a definite programme you are likely to exercise in so desultory and haphazard a manner as to fail to get the best results.

It is worth while, then, to outline a definite series of exercises, aimed at all-round development of the abdominal muscles, which may be performed in your own bedroom, and which will bring into action the entire series of neglected muscles, cause the absorption of adipose tissue, and give a healthful stimulus to heart, lungs, and abdominal viscera. Try these for a few mornings, just as an experiment.

Position A. Lie flat on the back, on bed or carpet, with hands over your head.

- Exercise 1. Body rigid, knees stiff. Raise right leg as far as possible, exhaling, knee still rigid; left leg also rigid, heel pressing down. Lower right leg till heel almost touches. Repeat several times.
- Exercise 2. Same as exercise 1, using left leg instead of right.
- Exercise 3. Same motion, using both legs, knees still rigid, and feet together.
- Exercise 4. Raise and lower legs alternately, bending the knees, and bringing thighs full against the chest, and then extending as if trying to run through the air.

Position B. Stand erect, feet and knees t gether; arms extended sidewise on level wi shoulders; joints of shoulders, elbows, a knees rigid.

Exercise 5. Pivot body back and for swinging arms in half circle, witho moving feet; thus bringing all the acti on the waist-muscles.

Exercise 6. Start from Position B, be right and left as far as possible, arms ways in line, right ascending as left scends, each alternately rising above t head and coming close to the thigh; f turned to look first at one hand and th at the other. Be sure to maintain rigid of elbows, shoulders, and legs, so that the action comes on muscles at the sid of the abdomen.

Position C. Standing, feet apart, knees be hands at sides.

Exercise 7. Swing arms high above he and as far back as possible, inhalir swing forward, bending body and rea ing back between the legs as far as p sible, exhaling. Eyes follow hands at times. The front abdominal muscles a muscles of the back are brought i vigorous action.

Position D. Stand erect, feet together at heels, toes at right angles, arms flexed agai chest.

Exercise 8. Raise hands high above the head, inhaling. Lunge forward with left foot, at right angles to right foot; left leg bent, right leg rigidly straight throughout the exercise. Face and shoulders in direction of left foot, thus bringing strain on abdominal muscles of right side. Stoop forward and touch floor with clinched fists in front of left foot, exhaling; resume original position of body, inhaling, bringing right arm to chest without altering position of legs and left arm.

Exercise 9. Same as number 8, but making lunge with right leg.

Exercise 10. Same position and exercise as 8, except that both fists are brought to the floor simultaneously in front of left foot, and both raised to the shoulder (always with body strongly turned so that the face is straight in line with left foot).

Exercise 11. Same as 10, with legs reversed.

Exercise 12. Begins like exercise 10, but as hands are brought to the shoulder after touching the floor, the left leg is brought back into original position D, heel to heel, and the arms then lifted above the head, inhaling. Lunge forward again with left foot, keeping hands still high in air. Then stoop, exhaling, and touching fists to floor in front of left foot as before.

Exercise 13. Same as 12, but lunging with right foot instead of left.

Position E. Stand erect, feet together, knees rigid.

Exercise 14. Bend forward, without bending the knees, and touch toes; resume erect position.

Exercise 15. Erect in Position E. Bend forward till your hands touch the floor; walk forward on hands, without moving feet, until body is fully extended, quadruped fashion, on hands and toes; legs and body rigid. Lower body till the chest (but not the abdomen) almost touches the floor; raise by power of the arms; hold the arms rigid, hands on floor, and walk forward till feet come between the hands; then raise to standing position. Face about and repeat. This exercise puts a strain on the abdominal muscles that will surprise you when you first test it.

Of course each of these exercises should be repeated several times; the exact number depending altogether on your physical condition. You may begin with two or three repetitions, and go on adding one or two daily till you repeat each exercise fifteen or twenty times. To go through the entire series, repeating each exercise twenty times, requires less than fifteen minutes; and if you will persevere you will come presently, as

your muscles gain tone, to find actual pleasure in the work.

Trading Hours for Years

Unless you have a definite programme you are likely to exercise in so desultory and haphazard a manner as to fail to get the best results. It is essential to outline a definite series of exercises and follow them up systematically. The series just suggested, aimed at all-round development of the abdominal muscles, is practised and recommended by George Bothner, whose wonderful symmetry of development attests the excellence of his methods of training.

Such a series of home exercises, combined with a rational dietary, will do wonders toward keeping you in health.

If you will persevere, I repeat, you will come, as your muscles gain tone, to find actual pleasure in the work. But the great difficulty is to get a really good start. If your system has been allowed to get very greatly out of repair, you may not have the will power to carry out a really effective course of gymnastics at home. You will need the stimulus of gymnasium associates, and the dominating influence of a trainer.

If you are corpulent, it will stimulate and encourage you to see men reduced, by a simple system of gymnastics and gymnasium games regularly carried out, from say 240 pounds in weight to a normal weight of 160.

When you see that such a transformation is not

only possible but a moral certainty under proper training, you will be encouraged to go ahead with vigor on the same road to health.

To get such results, however, it is necessary to exercise with such vigor as to cause profuse perspiration, and to induce a measure of fatigue. And the exercises should be conducted under judicious guidance, partly to insure their adequacy, partly to guard against excess.

The regeneration effected by even a brief period of rational training is sometimes almost magical.

As a typical instance, let me cite the case of a man who had sojourned three weeks at Brown's physical culture institution (Pine Hill Farm), at Garrison on the Hudson, near New York. He came to the institution corpulent and flabby of muscle, and suffering from "nervous insomnia and nervous indigestion"; when he went away he was thirty pounds lighter, his indigestion had disappeared, and, at home, he reported himself able to sleep early and late, oblivious to the sound of "poker parties and piano players in the neighboring apartments," and of trolley cars and early morning trucks.

In a letter written sometime later he says:

"I am *living* for the first time in several years. I am able to do more and better work with less strain that in many years. I wish that many business men whom I know, and the thousands whom I do not know, who let themselves get out of condition and who become physically unfit, and more or less affected with neurasthenia, on account of

overwork, lack of exercise, and too much eating and drinking, could possibly realize how good it feels to be alive and in first-class condition. I am certain that if they did they would let their business wait and ' beat it ' for a place where they can get themselves in shape. From my own experience I feel confident that there is no investment in the world that would be so beneficial or worth so much."

Such an admonition, born of experience, deserves your careful consideration.

You are too busy to follow such advice you say. The excuse is a common one. But the time will come when you will cease to indulge that particular sophistry. As you feel your powers failing, you will realize that your work is not fully accomplished; that it is good to go on a few years more in this wonderful world. Then you will seek advice about means to prolong your life. You will wonder if exercise would not be " good for you."

But if you delay too long you may then be answered as was an American millionaire well-known in the world of high finance, who at the age of about sixty sought a medical specialist to ask the same question. After examining him the specialist said something like this:

" You say, Mr. X., that someone has advised you to exercise. That would have been admirable advice ten or twenty years ago. But you have lived so long without exercise, have permitted your tissues to get into such a state of disrepair and degeneration, that is is now too late to hope to re-

store them to activity. You can only conserve the small measure of physical strength that you retain. Do *not* exercise. Take a taxi even if you have to go only a few blocks. Save all your strength and keep the machine going at low speed as long as you can."

To a friend the doctor said afterward that if Mr. X. had begun to exercise at the right age and had taken proper care of his originally good constitution, he might very well have hoped to live to be eighty, instead of dying, as he did, at sixty-five. Half an hour a day of the right sort of exercise at the right time would probably have insured him an additional ten or twenty years of life; but all his millions could not restore the lost opportunity or purchase for the financier an added hour.

And this case is absolutely typical. Such degeneration of the tissues as that which took the financier prematurely from the scene of his labors causes probably a majority of all deaths of those who live beyond forty. After middle life we have fought off the virulent microbes, our systems are largely immune to them; and the bodily machine wears out, like any other machine, more or less rapidly, according to the care that is taken of it.

Even pneumonia, that arch-enemy of the aged, is not primarily a germ disease. But for the lowered vitality of the body, due to sluggish functioning of the tissues in general and slackening heart action, the microbes, even if lodged in the lungs, would not be able to develop there.

The great difficulty is that most people cannot be

induced to shut the barn door until after the horse is stolen. If this was true of a man of business acumen and foresight, like the financier whose case was just cited, what can be expected of the ordinary mortal? At any rate, if you have read these pages, you are forewarned and if you elect to live a short and inactive life rather than to make bid for a long and active one, you at least make the choice knowingly.

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